MIAMI

Why Stop Learning? Dorothy Canfield Fisher

The Heredity of Richard Roe
David Starr Jordan

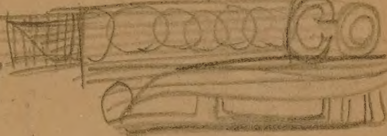
Heredity + The Family Life

m. Life at the Crossroads.

To get venous blood back to heart

Deepbreathing

Heart



ch 9

ch 17

29

" 42

" 47

Go thru ch + pick out scientific words.

Man is the tadpole of the archangel.

ology = Study of life

Aims of Health Educ.

1. To instruct children & youth so that they may conserve & improve their own health.

2. To establish in them the habits & principles of living which thruout their school life & in later years will assure that abundant vigor & vitality which provide the basis for the greatest possible happiness & service in personal, family & community life.

3. To influence parents and other adults, through the health education program for children, to better habits & attitudes, so that the school may become an effective agency for the promotion of the social aspects of health education in the family and community as well as in the school itself.

To improve the individual & community life of the future; to insure a better second generation and a still better third; a healthier & fitter nation & race.

Milton knew 8000 words
Shakespeare 15000 "

HYGIENE

A TEXTBOOK FOR COLLEGE STUDENTS

$D = \frac{m}{v}$

HYGIENE

A TEXTBOOK FOR COLLEGE STUDENTS

With Introductory Sections on Anatomy and Physiology, and Pathological Conditions

BY

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TO MY HUSBAND

Ernest Sidney Meredith

PREFACE

This volume is presented for the use of college students and others of similar educational status. No previous study of the subjects treated is presupposed. It is in this sense an elementary textbook. It is, however, addressed to those whose experience, methods of thought and vocabulary are at the adult level.

Parts I, II and III have been included as preliminary to the main portion of the book, Part IV. Parts II and III should not be omitted except in the case of students who obtain the same or more complete information on these subjects from other sources—as, for example, students of nursing.

The order suggested for the use of the various chapters is based on practical considerations. Theoretically it would be preferable to assign the chapters in order. Actually, it will no doubt often be found desirable to bring to the attention of students early in the college course some of the common pitfalls in the path of health, and the methods of avoiding them. It is suggested, therefore, that some of the chapters in Parts II and III be postponed, and that some of the chapters in Parts IV be assigned early in the course.

As stated in the text, the laboratory work of the course is held to be the daily living of the student. No other laboratory work is indicated, although, if time and circumstances permit, it is recommended that teachers supplement their classroom discussions by demonstrations and experiments. The main emphasis should be, we believe, on experiments, observations and inferences regarding health procedures in living from day to day. Such is logically the laboratory work to be conducted by the layman studying personal hygiene. The student should not receive the impression that a hygiene course is merely a condensed and incomplete study of anatomy and physiology.

I wish to express my indebtedness to my colleagues for much assistance in the preparation of the volume: to Katherine Pardee, M.D., Cathryn V. Riley, M.D. and Faith Fairfield, M.D., Assistant Professors of Hygiene and Assistant Physicians at Smith College, for reading parts of the manuscript and for giving valuable advice based on their classroom experience and their clinical consultations with students.

I am also deeply indebted to Myra Sampson, Ph.D., Professor of Physiology, Smith College; Abbie M. Turner, Ph.D., Professor of Physiology, Mount Holyoke College; Sydney M. Britton, M.D., Harvard Medical School; Douglas Thom, M.D., Director of Division of Mental Hygiene, Department of Mental Disease, Massachusetts, and Consulting Psychiatrist, Smith College; Frankwood Williams, M.D., Medical Director of the National Committee for Mental Hygiene; Abraham Myerson, M.D., Professor of Neurology, Tufts College Medical School; and Miss Dorothea Beach, Institute for the Coördination of Women's Interests, Smith College. These all gave generously of their time in the consideration of various chapters.

For her interest and skill in preparing most of the original drawings I wish to express gratitude to Faith Fairfield, M.D. A smaller number of very carefully prepared drawings are the work of Mrs. Elizabeth M. Kimball, Assistant Curator of Hillyer Art Gallery, Smith College. The original photographs were either taken by or under the direction of the members of the Department of Hygiene of Smith College.

The following publishers kindly lent illustrations and charts. I am indebted to them and to the authors of the books and articles for permission to use their valuable material.

P. Blakiston's Son & Co.

Halliburton, W. D. "Handbook of Physiology."
Brubaker, A. P. "Textbook of Physiology."
Bachmann and Bliss. "Essentials of Physiology and Pharmacodynamics."
Macneal, Ward J. "Pathogenic Microörganisms."
Lovett, Robert W. "Lateral Curvature of the Spine."
Morris. "Human Anatomy."
Evans, C. L. "Recent Advances in Physiology."

Hawk, P. B. "Physiological Chemistry."

Potter's. "Compend of Anatomy."

Macmillan Co. Williams, Jesse F. "Healthful Living."

Sever, J. W. "Principles of Orthopedic Surgery for Nurses."

Lea and Febiger. Coakley. "Diseases of the Nose and Throat."

Farr, C. B. "Internal Medicine for Nurses."

D. Appleton & Co. Barker and Siemans. "Race Hygiene and Heredity."

Rosenau, M. "Preventive Medicine and Hygiene."

World Book Co. Ritchie, J. W. "Human Physiology."

Henry Holt & Co. Martin. "Human Body." Read

William Wood & Co. Jones and Lovett. "Orthopedic Surgery."

Ginn & Co. Hough and Sedgwick. "Human Mechanism." Read

Yale University Press. Mendel, Lafayette, B. "Nutrition; The Chemistry of Life."

Dartmouth Alumni Magazine. Article by W. R. P. Emerson, Feb., 1925.

American Statistical Association Quarterly. Article by Myra Hulst, March, 1921.

Boston Medical and Surgical Journal. Article by F. C. and C. G. Benedict. August 1, 1918.

Journal of the American Medical Association. Article by Dr. Robert H. Halsey, August 27, 1921.

The Woman's Press.

Thanks are also due to Thomas D. Wood M.D., Columbia University, for permission to utilize his height-weight tables.

For other illustrative material and charts I am indebted to the United States Department of Agriculture; Office of the Surgeon General of the United States Army; Children's Bureau, U. S. Department of Labor; American Medical Association; American Child Hygiene Association; Women's Foundation for Health; and Harvard University, Department of Hygiene.

For much painstaking service in the preparation of the manuscript I am indebted to Mrs. Lea G. Mercer; and for assistance in the reading of the proof to Miss Mary P. Allison, and to several students in the Smith College School of Social Work, especially to Miss Lena Grimes, Miss Winifred Pritchard, and Miss Kathryn Potter. Much of the work on the index was done by Miss Agnes Scribner.

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The following order of assignment is one that it is believed will be practical for use in a course meeting once a week throughout the year. There are ordinarily from twenty-eight to thirty class meetings in a year. Since no assignment may be made for the first meeting of the class, and since time must be allowed for delay, omitted classes and review, assignments have been distributed, as follows, on the basis of twelve a semester, or twenty-four a year.

1. No assignment (Mannikin and skeleton)
2. Chapters 1, 2, part of 7
3. Chapters 3, 4, part of 7
4. Chapters 5, 6, part of 7
5. Chapters 8, 25
6. Chapters 26, 27
7. Chapters 9, 28
8. Chapter 29
9. Chapters 10, 30
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11. Chapter 31
12. Chapters 13, 32
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25. Chapters 22, 47, 48
26. Chapters 23, 24
27. No assignment
28. No assignment

PART I

INTRODUCTORY

Wed.

Other things being equal is the measure of power

1 good food
2 plenty of exercise
3 fresh air

24"x24" brain matter
24"x24" = 576 sq in brain matter

HYGIENE

A TEXTBOOK FOR COLLEGE STUDENTS

CHAPTER I

HEALTH AND DISEASE

Even a very few years ago, the introduction to a book on hygiene would have contained statements attempting to show the advantages of health. At last, however, the whole world seems to have awakened to an appreciation of the significance of health and to be seeking it eagerly, often frantically and in fantastic ways.

It is not so much a question, now, of the desirability of health, but of the methods by which it may be gained. It may be taken for granted that whatever one's aims may be—happiness, comfort, beauty, successful work, financial profit, service to one's kind, self-expression, or any of the possible ends sought in life—health is generally appreciated as the foundation for them all. As a factor in complete living of whatever sort, when all factors are weighed and measured, health would perhaps be most often placed at the top; for the qualities that make achievement possible in spite of poor health are qualities quite beyond the scope of the average individual, as he himself well recognizes. Even transitory symptoms, such as a headache, place most individuals out of the running temporarily, or so interfere with the pursuit of their aims that achievement of any sort for the time being is suspended.

The effect of health is quite generally recognized as that of freeing the individual from any possible hampering by an imperfectly acting body. This generation more than any other is demanding freedom, and demanding it as an actuality rather than as a figure of speech. When one's condition is

looked at squarely it is seen that one either is actually free or actually not free. To the extent that one is bound by a feeble body or by hampering habits, freedom is lacking. It is natural that a facing of facts and a search for freedom should lead to greater respect for the health that gives freedom from some of the most binding and disagreeable shackles.

Among the aims that have become very important in the present age, and that particularly require health, is the aim to have an active, exciting, adventurous life. In looking back on previous generations, it seems clear that there are now more individuals not contented with dull, drab, colorless routine. Almost no one now looks forward to a life of leisure or even to a life of limited tasks, but to continued, wide activity of some sort, to which any physical infirmity would be detrimental. Aristotle said "He who has health has hope, and he who has hope has everything."

Health is sought not only by those who wish to get the most out of life, but also by those who wish to put the most into it. Those who recognize most fully the interrelationship between society and its individual members seek health also, not only for their own needs, but in order to avoid being a menace or a handicap to the social or group welfare. There are those who feel their social obligation to the extent, for example, of guarding against distributing infection; but there are those who go farther and realize the degree to which society is hampered by the presence in it of those who will not equip themselves as fully as possible for their share of the group life. One's social value is at least partly in proportion to one's personal health.

For one reason or another the present search for health is well established. It has already produced a considerable increase in the average length of life, and a marked reduction in the frequency of many forms of illness. Its results have been shown during the past twenty-five years in ways that may be demonstrated by statistics. There is every reason to believe that the next twenty-five years will show further demonstrable improvement in health.

The desirability of health would be still more apparent if any very large number of people knew in their own lives what

real health is. An individual in bondage may be unable to comprehend the meaning of freedom; but give him a little freedom and the desire for more becomes compelling. The same is true in regard to health.

Those who most desire health are of two classes—those who are frankly ill and are made uncomfortable and inefficient by it; and those who have had at times at least a glimpse of what real health is, either in their own experience or through the observation of others.

Health is not merely freedom from disease, although it has long been so considered. It has been thought that there was a sharp dividing line between the well and the ill, the ill being frankly diseased, and the well being frankly well. The ill have usually been thought of as being in bed, and the well as being up and about. The ill have been thought of as needing medical attention; and the well as not needing it. According to this classification most people are well. But if health is defined more exactly than as absence of disease, it will be seen that by no means may most individuals be classified as really well. Health may be defined as a positive state of well-being, in which there is freedom from any disagreeable awareness of body functioning and a readiness of the body to act in all its functions and at all times freely and comfortably, when reasonable demands are made on it. It is possible to be very far from health and yet not diseased, and to be very far from disease and yet not well.

In any given group, perhaps ten per cent will be really well, ready for anything they may wish to do and able to do it with ease and comfort, "enjoying good health." Another ten per cent will be really ill, with well-defined ailments, that cause pain or disability, or that lead directly to such results.

Between the two extremes will be perhaps eighty per cent of individuals who can be classed as neither well nor ill—those who have minor imperfections and various sorts of disturbances of body functions. They are in a neutral state that is neither health nor disease, but that may become either according to circumstances. The state of being semi-well is so common that it excites no comment, usually being accepted as satisfactory health even though it is very near to disease.

There is a very narrow borderline at either extreme, so that the individual who considers himself well today may be definitely ill tomorrow, and the one who considers himself ill today may be well tomorrow.

If an individual in this major group of the semi-well is questioned regarding his health, he will readily say, often, that it is "good" or even "excellent." Further questioning may, however, reveal the fact that he is subject to headaches or backache, or pains in various places, from time to time or even constantly; that he "catches cold" often, or perhaps has chronic catarrh; that he has "trouble with his feet"; that he cannot eat certain articles of food, has a poor appetite, or is subject to constipation or indigestion; that he does not sleep well or wake refreshed, or perhaps is sleepy all the time; is easily fatigued, gets breathless on exertion; is nervous or depressed—or is troubled in any one of a hundred ways by the faulty working of his body.

These symptoms are extremely common. The vast proportion of individuals admit one or more of them. They may or may not indicate organic disease—in many cases not. They do, however, in all cases represent faulty functioning of some part of the body that should function without calling attention to itself.

There are those who ordinarily are not troubled with faulty functioning but who cannot claim to have really good health because it is not sufficiently reliable. It should not be necessary regularly, or even very often, to leave one's affairs in the air while one surrenders to the domination of a poorly functioning organ. The health of women used to be considered less good than that of men because it was less reliable than that of men, and less reliable than it has become during the past generation. A person in youth who can count on his health, barring accidents, is relatively rare; a person over forty who functions constantly well is rare indeed.

Examinations by the thousand have been done by doctors in connection with the army, industry, schools, colleges, and insurance companies. The evidence all shows that malfunction, physical defects and diseased organs are extremely common. A quite general lack of perfection has been observed

Many of the same individuals who show the symptoms of ill health that have been mentioned above will be found to have physical defects also. Among the common defects are: poor eyes, that may not be able to stand the strain of long hours of study or other close work; poor teeth, that may abscess and ache and cause poisoning of the whole body; diseased tonsils, that may become the focus for infection

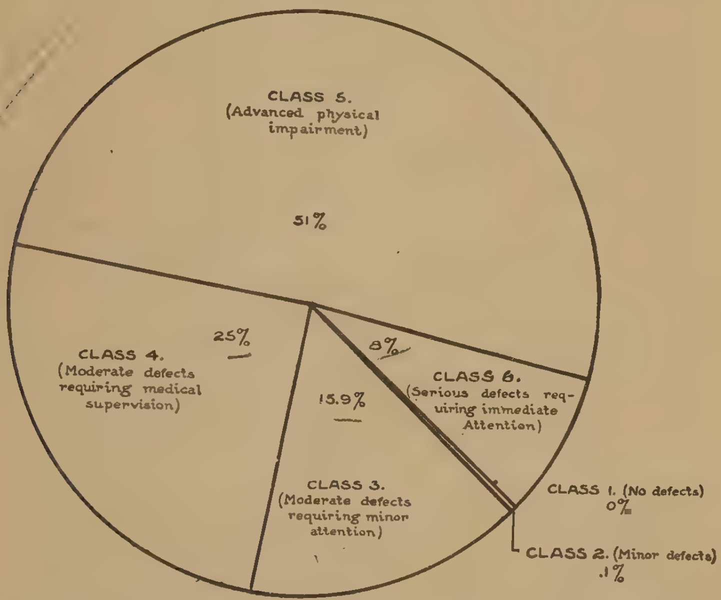


Fig. 1.—Results of the examinations conducted by the Life Extension Institute of 5000 persons who, for the most part, did not consider themselves sick. (From Moore, "Public Health in the United States." Published by Harper & Bros.)

elsewhere; deformed nasal passages, that may lead to chronic and acute infection; crooked and bent backs, that may give pain or make the whole mechanics of the body faulty; flat or weak feet, that may interfere with their comfortable use; feeble hearts, that may serve only fairly well in the limited activity they permit; latently diseased lungs, that may become actively so under unusual strain; sagging of abdominal organs, that may interfere with the function of digestion and

secondarily with the functions of other abdominal and pelvic organs; chronic infection, that taxes the body defenses to keep it within bounds, and that may fail to be controlled. These are the commonest physical defects. They may or may not constitute actual disease; but they are certain to interfere with the harmonious working of the body in some respect. If such physical defects do represent disease, the disease may be in the earliest, incipient stage; or it may be latent, not active; or it may be active but unsuspected or unrecognized. Many defects represent disease that is now past, but has left its mark in present discernible defects and faulty functioning.

A very large proportion of individuals show one or more of these defects, to which may be due the ailments to which they are subject. It should be emphasized, however, that the ailment may have no reference to any diseased organ; and that an individual with no imperfections may suffer from disturbed function as genuinely as he who has diseased organs. His suffering is, however, due to the fact that he does not know how to help his body to run smoothly, or is unwilling to take the steps necessary to secure smooth running. There would be no object in referring to the prevalence of imperfections and malfunctions, were it not for the fact that many of them are preventable. Many individuals are quite unnecessarily below a fair standard of health.

It is difficult to consider health without considering—briefly here, and occasionally in subsequent chapters—its opposite, disease. The implication is not, however, that health is merely absence of disease, or that the search for health is best carried on by trying to avoid disease. Without any reference to disease, much might be said regarding the care of the body so as to produce health. But a consideration of the ways in which the body may be harmed throws into desirable contrast the ways in which it may be helped.

There is a vast amount of misconception about the nature of disease, which leads to erroneous ways of trying to avoid it. If one looked upon disease as a visitation of evil spirits, for example, one might seek health by prayer while neglecting obvious physical needs. It seems desirable that all adults should have a rather definite idea of what constitutes ill health

and the possible underlying causes of it. In some circumstances both in disease and in health, nothing else serves as a foundation for suitable behavior so well as does a concept of the nature of disease.

It is an advantage to remove from the realm of mystery as many as possible of the common phenomena. Even a slight knowledge of pathological (disease) conditions is likely to lead to less fear of them and more appropriate action toward them. In discussing disease, however, it is not intended to suggest that laymen should attempt to deal with it in any way whatsoever when medical advice is available.

Disease is classified in several ways. First, it is classified according to the time at which its cause originated, as hereditary, congenital, or acquired. Hereditary disease is that which depends on determining factors in the germ plasm, present in the germ cells before conception. Congenital disease is that which was acquired before birth, during intra-uterine life. Acquired disease is that which originates at any time from birth onward. Strictly speaking, acquired disease includes all disease that is not hereditary, and therefore includes congenital disease. Practically, it is customary to differentiate between disease that is acquired before birth and that acquired after birth.

Acquired disease is classified primarily, according to the effects produced in the body, as either organic or functional. Organic disease is that sort which involves a change in the structure of any part of the body. Functional disease involves a change in the way in which an organ behaves, or imperfect working of an organ that is not, so far as may be determined, structurally changed. It is possible to have structural defects that do not constitute disease and that produce no change of function. One may perhaps, for example, breathe as well through a crooked nose as through a straight one. Usually, however, a change of structure involves a change in the way a part works. This is not called functional disease, inasmuch as structure is changed. Only that which is exclusively malbehavior of a part is called functional disease. A heart may be functioning badly because it is structurally damaged or because it has been over-strained. The former is organic

disease with poor function; the latter is known as functional disease.

The causes of organic disease are numerous, and include prominently the following: infection (Chapter 19), poisons (Chapter 22), trauma or injury (Chapter 23), and tumors (Chapter 24). The causes of functional disease are likely to be lack of skill in the daily living.

The symptoms that are produced in functional disease are indistinguishable to the layman from the symptoms due to organic disease. It is impossible for him to determine whether a pain in the abdomen is due to dietary errors that cause the digestive tract to function poorly, or to an abscess of the appendix, for example. This one fact regarding symptoms, were it always understood, would be of the greatest value in suggesting the correct procedure in the presence of symptoms of ill health—the procedure being the securing of medical advice regarding its cause. It frequently takes much medical skill to determine whether a symptom is due to functional or organic disease. Too ready conclusions by laymen may be indeed rash.

Organic disease is rare in comparison with functional disease. Functional disease constitutes the bulk of the ill health, as statistics from army, insurance, industry, schools and colleges show. More persons are uncomfortable and incapacitated than are seriously organically ill. There are, naturally, various degrees of impairment of function, resulting in various degrees of inability to pursue one's ends, and leading in varying length of time to more serious results.

There is a relationship between what is at first purely functional disorder and true organic disease. Eye strain and its attending symptoms may be a precursor of definite eye disease. Furthermore, the same faulty conduct of life may lead on the one hand to faulty functioning of organs and simultaneously to organic disease. Exposure to cold, for example, may lead to faulty functioning of the circulation and a chill, at the same time leading to an infection of the mucous membrane of the respiratory tract. It is therefore true that the individual who lives so as to produce proper functioning of his organs is doing much at the same time to maintain their normal structure.

According to their duration diseases may be classified as acute, sub-acute, or chronic. Acute disease is that which arises rather suddenly and tends to be terminated in one way or another in a short time. Sub-acute disease is that which originates suddenly, as acute disease, but "hangs on," or it may have a more gradual onset as well as a gradual termination. Chronic disease may be the end result of acute or sub-

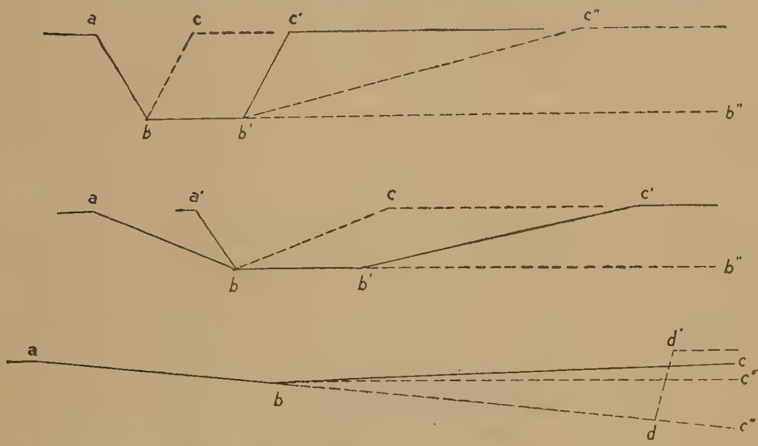


FIG. 2.—1. Diagram indicating acute onset and recovery (abc); acute onset, short illness and prompt recovery (abb′c′); acute onset, short illness, slower recovery (abb′c″); chronic illness, following acute illness (abb′b″). 2. Diagram indicating subacute onset (ab) acute onset (a′b) gradual recovery (abc) or (abb′c′), chronic illness (abb′b″). 3. Diagram indicating chronic illness with slow onset (ab); slow recovery (abc), continuing disease (abc′) or progressive disease (abc″). Line dd″ indicates the occasional possibility of quick recovery from chronic illness by such measures as, for example, a surgical operation.

acute illness, or it may never have been either of these, its onset not having been accompanied by an attack of any kind of illness. Generally speaking, acute illnesses tend to terminate in a few days or a few weeks. Sub-acute illnesses last somewhat longer, up to a few months. Chronic ones usually last for years.

There is some confusion in the minds of laymen about the relative severity and seriousness of acute and chronic ailments, acute ones generally being considered the most serious.

This is not necessarily so, as may be seen by comparing an acute inflammation of the nose (the ordinary cold) with a chronic catarrh. From the point of view of inconvenience and effect on general health, and on length of life, many acute illnesses are not to be compared with chronic illnesses.

If disease were, as some suppose, in each case an entity, it would be a relatively simple matter to study each disease separately and to prevent it or cure it—that is, it would be relatively simple compared with the actual state of affairs. Those few forms of disease that seem to depend almost entirely on a single factor are readily enough controlled if one wishes to do so. If, for example, illness is solely due to improper ventilation, all that is necessary is to provide a sufficient amount of fresh air.

Most forms of disease are not simple, however, but represent the interaction of many factors, which perhaps may not be readily recognized. The present methods of control of disease depend on the recognition of as many contributing factors as possible, and the correction of as many as possible.

If one were asked to give the cause of a disease such as cholera one would unhesitatingly reply "the bacterium of cholera." Yet Pettenkofer years ago commented on the fact that cholera does not inevitably result from the coming together of an individual and the cholera germ, but that three main factors determine whether the individual exposed to cholera develops the disease or not. These factors are: the condition of the individual, the condition of the germs, and the environmental factors that influence both.

It is convenient to use, as he did, the letters X, Y and Z to indicate respectively the individual, the injuring agent, and the environment. The same symbols may be used in respect to any and every disease. In the vast proportion of diseases all three factors have a part.

Among the many factors included under the symbol X (meaning the individual) must be included everything that makes a man what he is. It cannot always be determined precisely what it is about an individual that makes him a prey to any given form of disease; but it is certain that individuals do vary in their reaction to injuring agents and to

environment, so that they are more or less responsive to given injuring agents. The determining factor may be heredity. Races and families vary in resistance to given injuring agents. Some races are practically immune to certain diseases, as are some families. On the other hand, there are familial tendencies observed to weakness of various sorts. The determining factor may be a condition that influenced the constitution before birth, or at birth, or since. An individual may be what he is because of his nurture and care in infancy, or the lack of it, or because of past accidents or illnesses.

Whatever the physical status is at present, it represents either strength or weakness in respect to possibilities of further harm. The strength lies in sound, well-nourished tissues and organs, conducting their functions well, and in the presence of the special chemical and cellular defenses against bacteria. The weakness consists in the opposite condition—the presence of defective, under-nourished and diseased organs, physiological malfunction, and absence of special bacterial defenses.

The individual is a product of his past, but he is also a product of his present. What he does is as important as what he is. No consideration of the physical status is complete without a consideration of the habits also. A man's behavior is a part of himself. It changes him from day to day, or keeps him the same, as the case may be. The effect of strain or disuse of muscles, organs, nerves or mind; the effect of deficiencies, deprivations or excesses of substances produced in the body or taken into it, are daily remaking a man's constitution.

Furthermore, a man's behavior affects not only himself, making him more or less susceptible to disease, but it often affects also the injuring agent itself and the environment. Man may reduce his likelihood of having malaria by using quinine as a chemical defense. This changes him as a potential victim. The X factor has been changed. He may also reduce his likelihood of malaria by attacking the breeding place of the mosquito and destroying it. In such a case the Y factor has been changed. By changing his environment, either by fully screening his house or by moving to a non-malarial region, he may affect the Z factor.

Since what a man does depends on his mental state, that certainly must be included in any consideration of X factors. A man's mental and emotional state has affected his past, does affect his present, and will affect his future.

The X factors are by all odds the most important factors in relation to disease, since man may control not only himself and his behavior but also to some degree so act as to minimize the adverse aspects of the Y and Z factors.

The Y factors are as numerous and various as the X factors. Chief among the agents that injure man must be mentioned the bacteria, but there are many injuring agents of a mechanical, physical or chemical nature, among which may be mentioned the effect of heat, cold, the sun, electricity, X-ray, atmospheric pressure, irritants and poisons. It should be noted that many of the possibly injuring agents are potentially beneficial to man and are used more by him for his benefit than to his harm, with the exception of the pathogenic (disease-producing) bacteria. Most injuring agents do not injure if man's behavior in relation to them is satisfactory. Even the pathogenic bacteria are not invariably injurious. The condition may be such that given bacteria have no effect—as is the case in respect to smallpox in the vaccinated; or the behavior may be such as to place the bacteria at a disadvantage.

The Z factor is broadly inclusive of everything that may affect health, exclusive of man himself and specific injuring agents. It includes such factors as the climate, the density of population, living and working conditions, housing, the occupation, poverty or wealth, community hygiene—in fact all environmental, economic and social factors.

The physical environment and the social and economic conditions in which a man finds himself make much difference in the man himself and often affect the injuring agent favorably or adversely. For example, overcrowding in houses or working places, bad air, too long hours of industrial labor, and inadequate pay, give conditions that favor the increase of tuberculosis, both because of the effect on the individual and on the tubercle bacillus. Infantile intestinal disease that occurs so frequently in the summer and constitutes so large a cause of infant mortality, is thought to be due to climatic conditions

that adversely affect the baby itself, lowering its resistance, and at the same time favorably affect the pathogenic bacteria by providing conditions in which they grow well. As a cause of illness, overclothing the baby in summer is almost as important as feeding him milk that has been spoiled by heat and contaminated by summer dust, bearing bacteria. In many cases environmental factors of one sort or another turn the balance in favor either of the individual or of the bacteria.

It will be seen that disease is not a monstrous phenomenon unrelated to life, falling upon individuals regardless of the circumstances. It is the sum of a large number of factors, often of very many small factors, of which none in itself would perhaps be capable of causing disease. Morgagni in the 18th century showed that disease is a process, not an entity. This conception of disease is the one that has made possible the modern advances in both the prevention and cure of disease. Study is being carried on not only of man himself, the whole individual and all that makes him what he is, but of all sorts of injuring agents, and of all sorts of environmental conditions.

It is constantly becoming more evident that in dealing with disease many varieties of knowledge must be utilized, and that the cause of any given disease is seldom simple. Laymen often have the impression, perhaps gained from ardent proponents of some special method of treatment, that most disease is due to some particular cause—such as misplaced vertebrae, or the eating of meat. Sometimes they gain a similar impression, that there is a single cause of disease, from specialists in the various branches of medicine, who must necessarily bring to the public attention the particular factor that they discover to be related to disease. It is a mistake for laymen to get the impression that these specialists feel that there is nothing else of importance that has any bearing on disease. The specialists themselves do not think that, but only their undiscriminating followers. Only faddists and quacks have the temerity to point to one factor that causes disease, and insist on attention to that only. One should beware of any cult or individual that considers disease in relation to one

cause only, or that maintains it can be prevented or cured by attention only to that particular cause.

In this volume consideration is given almost exclusively to the X factor, man himself, and particularly to that aspect of man represented by his behavior in his daily life, and the effect of it on his health.

CHAPTER II

THE PREVENTION OF DISEASE

The first efforts toward health involved the definite objective implied in curative medicine. The aim was to do away with a disease when it was found to be present. Advances took place in the methods of diagnosis of disease and in methods of treatment. At about the middle of the last century there began the present more inclusive interest in disease, that involves the discovery of conditions that lead to it and their prevention, so that a disease should not have to be cured because it had not appeared. This greatly widened the scope of medical science. Preventive medicine now includes not only efforts for the prevention of definite diseases, but also efforts for the increment of health by the improvement of body functioning, even though no actual disease is threatening. The science of preventive medicine includes public health measures used by the community for itself and its members; and personal health measures used by and for individuals.

The prevention of disease by public methods began long ago, when it was first observed that certain diseases are communicated from one to the other. The first important public health measures were along the line of isolation. The isolation of the leper is traditional. From time to time throughout history isolation has been effectively used to prevent the spread of disease. The nineteenth century saw the development to a great degree of the isolation or "contagious" hospital, for the control of the epidemic diseases. Isolation is still one of the most important public health measures, but it often fails because individuals are not sufficiently early isolated, and because not all those who carry pathogenic bacteria may be isolated.

Then came the era of cleanliness and disinfection, typified by community sanitation. Some diseases not successfully

attacked by isolation were found to be preventable by sanitary measures. Of the diseases that were thus markedly

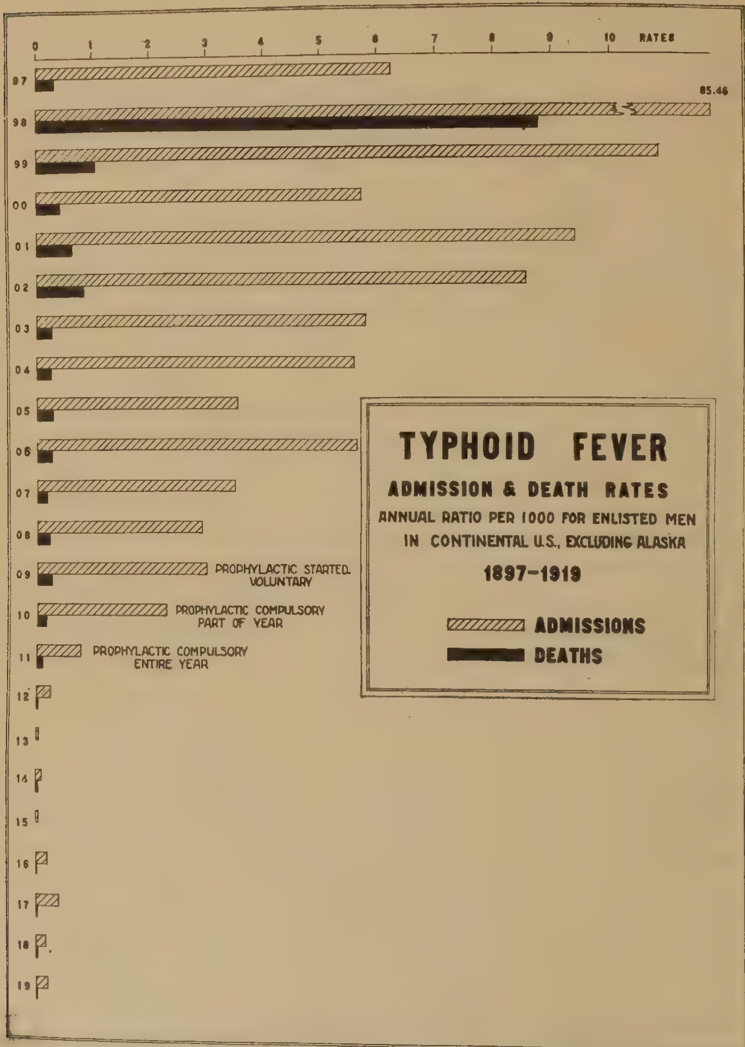


FIG. 3.—(Used by permission of the Surgeon General of the United States Army.)

reduced in frequency may be mentioned typhoid, which is spread about very largely through infected water. The

disinfection of sewage containing intestinal bacteria before turning it into places where it could contaminate the water supply, and the subsequent purification of the water itself, led to a remarkable reduction of typhoid and other intestinal infections. The public regulation of the milk supply and the laws regarding the pasteurization of milk also reduced typhoid, as well as tuberculosis from bovine sources and many other infections that are often carried in milk.

It will be noted that public health began as an effort to combat the communicable diseases, by the use of measures more economically and successfully carried out through community action than through individual action. Boards of health and departments of sanitary engineering came into being. It is notable that the New York Board of Health was established in 1866 to combat cholera. The practical non-existence of cholera in New York today testifies to the efficiency of boards of health against some of the formerly very serious epidemic diseases.

Although up until a comparatively recent time the direct attack on communicable disease by isolation and sanitation formed the major part of public health work, these same diseases are now receiving attention from still other points of view; and non-communicable diseases—such as were formerly thought not to be the concern of public health boards—are also receiving public attention. The most recent development in public health is the effort to provide against the faulty behavior of individuals themselves that counteracts all the good that the group efforts may produce. The health education of its heedless members is now thought to be a legitimate undertaking of the group. One of the important public health works now carried on is that for the prevention of infant mortality. It includes attention to many matters concerning the welfare of the infant, not the least of which is the education of the mother regarding its care.

Even the cure of disease has in some cases been taken on as a public function, on the principle that disease of a communicable nature springs from other cases, and if more disease is to be prevented, the existing cases must be cured. Great public campaigns that are being waged against such diseases

as hookworm and malaria involve the cure of existing cases of these diseases, in order to prevent their spread. There are many publicly paid for hospitals, sanatoria and clinics intended both for the cure of existing illness and for the prevention of more illness. Tuberculosis was one of the first diseases to be dealt with in this way. Some of the public clinics are not concerned with communicable disease, but with other common causes of ill health. There are, for example, well baby clinics, in which the consideration of the proper feeding of the baby is an important point. The public providing of

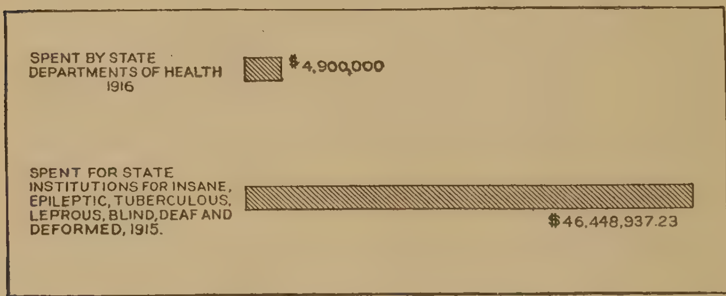


Fig. 4.—Amounts expended by the people of all the states through their state governments for health work and for the care of defective persons in institutions. (From Moore, "Public Health in the United States." Published by Harper & Bros.)

nursing care was one of the earlier and now most important measures of attack on existing disease. Recently the provision of curative and preventive substances, such as the antitoxin used against diphtheria and the vaccine used against typhoid, has assumed large proportions. Sometimes the public health campaigns against disease—for example, those against tuberculosis and venereal disease—at times must leave the realm of medicine entirely, and make their attack on the social conditions that are important factors in perpetuating the disease.

The slogan of the New York City Department of Health has been "Public health is purchasable." It is true that a vast amount of knowledge is available for the protection of the public health—such knowledge that, if applied, would still more reduce the sickness and death rates of communities. The emphasis on the fact that public health is purchasable is

desirable in order to call attention to the existence of such knowledge and its applicability to communities through their expenditure of money. But although public health is purchasable as indicated, it is often not purchased because of the fact that the public does not know what to purchase and does not know why it should spend money in this way. Hence the value of the education of the individual in health matters. It should result in not mere willingness but eagerness to protect itself by spending money for public preventive measures. It has so resulted to a considerable degree in recent years, although to nothing like the degree that it might and will in the next generation.

There is a close relation between individual health and community health. Each favors the other. The conduct of the community affects the individual; and the conduct of the individual affects the group. Even when all has been done that may be done publicly, personal behavior may be such as to interfere with the individual's receiving the benefits of the group health work himself, and may even interfere with others' receiving them. Measures adopted by the enlightened may be entirely vitiated by the individual's behavior. For example, the community may see to it that pasteurized milk is provided its members, yet the milk may be grossly contaminated by the consumer as soon as it reaches his home. This illustrates behavior of an individual nullifying public health measures to his own disadvantage. An illustration of individual behavior nullifying the effect of public health measures in such a way as to harm others is that of the careless sneeze in a well-ventilated classroom, rendering the good air, provided according to the dictates of public health, dangerous to those in the vicinity of the sneeze. The harm that often extends from one's self to others makes the problem of personal behavior still more important. Certain infractions of health principles communities do not allow individuals to commit because they affect others. The laws regulating isolation of communicable disease are very strict. A few other regulations are also enforced—such as that against spitting on the sidewalk. Other infractions of health principles individuals are left free to commit, when they cannot be considered more than

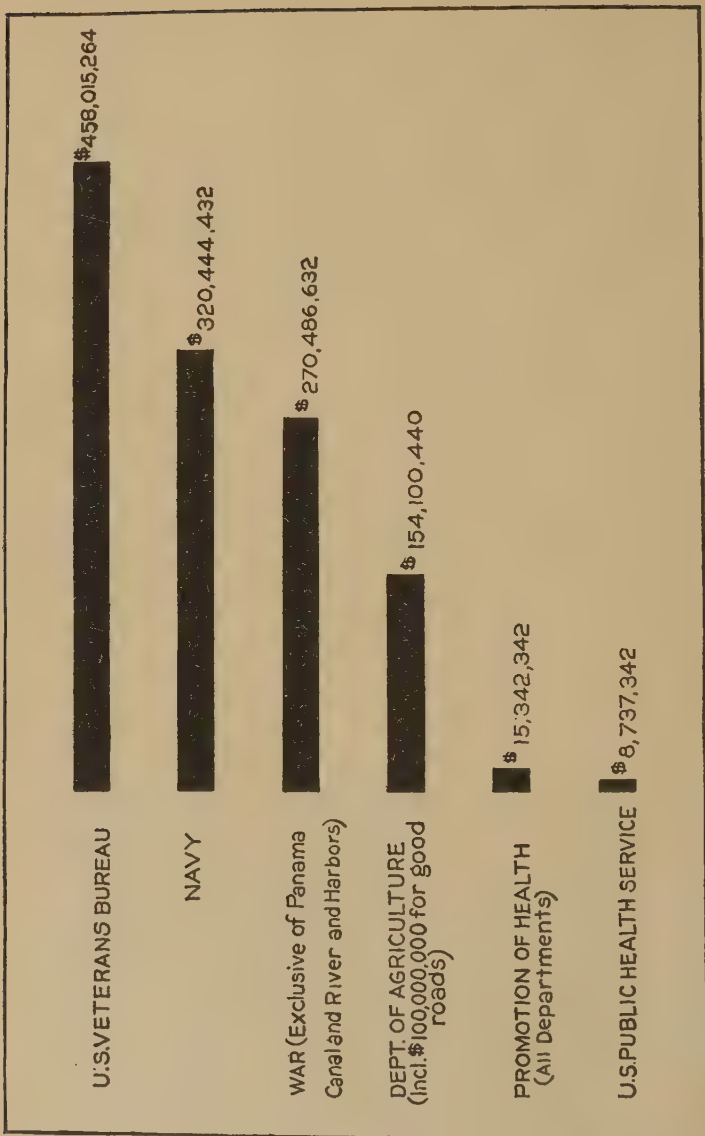


FIG. 5.—Amounts provided by the federal budget, 1923–24, for various departments and bureaus of the federal government. (From Moore, "Public Health in the United States." Published by Harper & Bros.)

one's own affair. Perhaps in time the interrelation between individuals and the community will be seen to be so close that individuals will not allow each other to commit the errors that lead, for example, to nervous breakdown and the resulting loss to the group due to its having to support in idleness ablebodied but handicapped individuals. There may, even, be community regulations preventing individuals from dieting to the extent of predisposing to tuberculosis and possible dependency on the State. At present, and perhaps forever, there is only moral law and common sense to dissuade individuals from the acquiring of needless illness.

Preventive medicine involves the wise conduct of each with others in the group life for the benefit of each, and wise conduct of each alone in his individual life for the benefit of himself and also of others.

The aim of public health is, in the last analysis, the health of the individuals of the group—the extension of the length of life, the prevention of early avoidable death, the prevention also of the large mass of illness that is not fatal but disabling in various degrees, and the improvement of the quality of life. Important as are the measures adopted by communities with those ends in view, and successful as they are in respect to some conditions, there is nevertheless an enormous field of preventive medicine beyond the scope of group efforts.

Preventive medicine in relation to the individual, directly and indirectly for the individual's own benefit, is newer than the preventive medicine carried on publicly. For this reason there is less decrease in the disease conditions due to personal living habits than in those due to faulty community hygiene. It is also true that there has been less reduction in disease that can be cured by personal living than in those that can be cured by medical treatment. There is almost if not quite as much premature degeneration of the heart and the kidneys as there was formerly. Some statistics seem to indicate that there is even more, because of unfavorable predisposing factors in present customs not balanced by increased personal efforts to prevent harm from these conditions. It is certain that large numbers of individuals are saved from one sort of disease by public preventive measures, only to fall

victims to others because of lack of personal preventive measures.

This means that the application of science to personal living has not kept pace with its application in public health or curative medicine. For example, far fewer cases of typhoid occur, because of the purification of water and sewage; and far more cases are cured, because of increased medical skill. Those cases that do occur, however, might practically all be prevented if the individual appreciated that his part in preventive medicine includes inoculation against typhoid. As has been shown, there is a corresponding increase in the occurrence of deterioration at middle age and of "nervous breakdown," those conditions not being preventable by public health measures, but dependent largely on individual conduct of life. Wherever public health has devised preventive measures or medicine has devised curative methods, we find decreasing sickness and death rates. Wherever the regulation of life is the important factor, we find, as a rule, either stationary or only slowly declining rates.

Yet there is no reason why individuals should not take advantage to a larger degree of the sciences that offer, if individuals will accept them, vastly increasing facilities for individual health guidance. There is enough knowledge available, if it were applied, to cause a corresponding decrease in the ailments caused by faulty living. Science has interested itself in recent years particularly in the finer points of living. It has much to offer the individual who would formerly have been considered well and not needing attention.

Medical science during the nineteenth century was newly in possession of important knowledge that it naturally applied first to the ill, because of their obvious needs. Gradually, however, it became apparent both to physicians and to laymen that it was shortsighted to wait until illness appeared. The use of medical science for repair work involves to some degree the prevention of further harm. Good medical care during, for example, scarlet fever or tonsilitis or an acute ear infection results in preventing a large amount of subsequent illness. But the use of medical science exclusively for repair involves a waste of time, money, effort and effectiveness, even of life

itself. Its use for guidance while health is still present and disease remote, represents a corresponding saving in all these important respects. It is clear that a small fraction of the time and effort devoted to cure would, if devoted to prevention, go farther and give better results.

Medical science has therefore interested itself in the well; it remains for the well to interest themselves in their own health, in order to keep it. Medical science having placed itself at the disposal of the well, it remains for the individual to get in contact with it. This may be done in two ways; first, by learning as much as a layman needs to know regarding the make-up of the body and its care in general; second, by securing personal health guidance. Both sorts of contact with medical science are necessary. Theoretically, the prevention of illness is as personal a matter as the cure of illness. Practically, an individual does very well most of the time if guided only by general knowledge which he applies intelligently to himself, and if he frequently seeks personal advice based on a study of his individual needs—such study as no layman is prepared to give his own body.

Personal preventive medicine rests then on two foundations: the study of hygiene, on the one hand; and the personal health consultation after physical examination, on the other. Neither is quite so effective if the other is missing. It is impossible for a medical consultant to make clear to an individual at the time of examination and consultation why he is advised to do thus and so, and almost impossible to gain his respect for the advice and his coöperation in carrying it out, if he has not already some general knowledge to which to relate the particular information he receives about himself. It requires much more time, is less interesting to the individual, is likely to give him queer notions and misconceptions about what has been said, and is generally unsatisfactory, if the individual has no knowledge of the body as a starting point.

On the other hand, a knowledge of the principles of hygiene is more effective if supplemented by an opportunity for the personal application of the principles to one's own needs. The individual often applies nothing at all of what he learns in

the classroom, or he may apply only part of it, or he may apply it at the wrong point. Important as is hygiene teaching by itself, or personal consultation by itself, each is more satisfactory if supplemented by the other.

The physical examination of the ill is the foundation of curative medicine. Yet it is possible for physicians to treat some illnesses without giving the patient a full examination. The physical examination that is the foundation of preventive medicine is not always necessary before any modification of behavior is introduced. It is possible for an individual to change his conduct so as to prevent illness, or for the physician to advise him regarding changes of conduct, without a complete preliminary examination. There are times, however, when complete examinations are the only sound foundation for any treatment or advice or change of ways of living. More and more it is being realized that efforts in the direction of health are soundest when, by physical examination, the status of the individual has been determined, and by reëxamination the results checked up.

Physical examinations of the well had been done by the thousand for other purposes before their function in connection with health maintenance and preventive medicine became prominent. They were then done largely for the purposes of classification of individuals. For example, insurance companies wished to know who were "good risks"; armies wished to know who would be good soldiers; industries wished to know who would be good workers and at what kind of work; colleges wished to know who would be likely to be able to finish college successfully; athletic directors wished to know who would be good team members. Physical examinations must continue to be done for this purpose in order that those who have the duty of assigning individuals to different groups may have the information they need.

Although similar in method, such examinations as are done for classification are different in purpose from those intended to serve as a starting point for health maintenance. Very many individuals, either voluntarily or as a routine of the institution with which they are connected, have had physical examinations within the past ten years that were not solely for

the purpose of determining present status as a basis for classification, but were also for the purpose of determining where the present status and habits are leading—examinations that not only determine that no disease is present but that none is threatening, and that the individual is headed toward continued health.

The direction in which health is proceeding may be determined by the study of existing defects or abnormalities, hereditary or personal tendencies, and past and present habits. In order to be complete, the examination should include the whole past history of the health as provided by the individual himself and those that know about his health past—his previous medical advisers. It should also include a report on the family health, not because diseases are inherited as such, but because the report may indicate tendencies the individual may have to learn to avoid. It should include also the description of the health from the individual's own point of view, the ways in which it is to him unsatisfactory. The patient who withholds any information in reply to questions that sometimes seem irrelevant or unimportant, is perhaps making futile the entire examination and all the advice he receives. It may be that the points omitted were just the points that would have made the whole situation clear. When physical examinations and health consultations fail to produce results, it may be for this reason—that full information regarding the past and the present was not at hand.

After all the information is in, the examiner uses his diagnostic methods to determine to what degree and in what respects the past and the present are liabilities, and to what degree and in what respects they are assets. The next step is a discussion which may have to be carried on at intervals over a long period, accompanied by reëxaminations, in an effort to reduce the amount of liabilities and to increase the assets. After the examination and consultation, begins the work of the individual in the application of the knowledge he has received to his daily life.

One often hears it said, "I placed myself in the doctor's hands and he hasn't helped me at all," or "I have been to six different doctors and I am no better than before." It should

be understood that doctors cannot create health, but can only share the responsibility for it. When sickness is present no physician can guarantee cure. Too much depends upon the human material with which he has to work—the constitution and the behavior of the individual. But in treating illness he is willing to assume the major part of the responsibility, providing he can have the patient under his control and have his absolute obedience. In conditions where the physician cannot have absolute control, the responsibility for giving good advice is his, but the responsibility for acting on it is on the patient. Health is, in the last analysis, of the individual, by the individual, and for the individual.

This sort of personal preventive medicine represents one of the refinements of the use of medical science. It is a difficult matter for the physician to detect slight variations from health and the causes therefore, and it is a difficult matter for patients to become interested in these same minor variations and to do their part in overcoming them. It is easier for both to be confronted by frank illness. All the powers of both physician and layman are needed to appreciate the very earliest signs of ill health, and to act suitably on the basis of their discovery.

When advice has been given after a physical examination, in a large proportion of cases it is not fully acted upon. Perhaps there is no tendency more marked in man than the unwillingness to accept advice, even from experts. In regard to health matters one is very prone to think that even the expert, for some reason or other, does not understand one's own person. Furthermore, doing as another advises may seem like too complete a surrender of the individuality. Yet following medical advice at the slightest sign of departure from normal, may mean all the difference between health and disease. Those who feel that they have not profited by putting themselves in the doctor's hands often really have not done so at all. When they have not done as advised, but as they thought best, they are not in the doctor's hands but in their own.

Advice regarding daily living is noticeably less often followed than advice that involves a prescription for medicine.

Personal inclination is less interfered with by taking medicine than by change of habits. It is easy to take medicine and it savors of the magical. Sometimes it is even supposed that more medical skill is exhibited in prescribing medicine, or that the physician is taking the situation more seriously when he does so. For one reason or another, if medicine is given it is usually taken, whereas "simple" advice about living often is not. An individual who complains of lack of results from health consultations may have done all but the one most important thing in his case. If thoroughly good results are to be expected, the individual must respect the possibilities in even minor changes in living, and must follow closely all the advice he receives.

There is a tendency to expect either too much of medical science or too little. Ignorance is at the root of either mistaken expectation. There are those who expect too little because they know too little of the possibilities of modern medicine. Knowing nothing of the subject themselves, they do not even know that anybody knows. But such ignorance does not always lead to expecting too little. It may lead to expecting far too much, even to demanding miracles. Those who expect nothing are often those who in their ignorance have been through the stage of expecting everything, and have naturally been disappointed. It is magic they have looked for, as in the ancient days of incantations—an outwitting of natural laws. Finding that medical science could not avert the inevitable, they illogically go to the other extreme and conclude that medical science can avert nothing. In their reaction they may wisely learn, however, to ask of physicians that which physicians can give, an interpretation of the laws of health as they apply to themselves, and guidance in conforming to them. It is up to the individual to get sufficient sound advice, and then to live accordingly. The physician's responsibility ends when he has given his advice—at the point where the individual's responsibility becomes the greatest.

Colleges offer an excellent opportunity for this most advanced type of health work, which requires for its success so much coöperation on the part of the individual. It may be expected to be most successful among those who are presum-

ably the most intelligent. Furthermore, students in college are usually those who have had good care during childhood and youth and are already in good health, as the term good health is popularly interpreted. Finally, environmental and other accessory conditions are usually more satisfactory than is customary in the population as a whole. For a number of reasons the students of colleges should expect a constant improvement in health during their undergraduate years, providing they can grasp the significance of their own behavior in relation to their health, and of the provisions that are made for their assistance in reaching a high level of health.

B.

CHAPTER III

INSTINCT, HABIT AND KNOWLEDGE, IN RELATION TO HEALTH ATTAINMENT

Health has been spoken of as if it were something that might legitimately be sought in the expectation that it may be secured by an effort. This is very nearly the case. Health, like disease, may be acquired.

Heredity, however, provides an initial advantage that makes more easily possible a high level of health. The inheritance of a good constitution is one of the most enviable of the gifts of heredity. But it does not by any means guarantee health. An individual's status at any given time is the product of two factors: his original constitution, and the changes made in it by what has happened to him since birth. There are those whose physique is so good that it remains so in spite of odds in environment, faults in training, lack of care in childhood, illnesses and accidents, and even in spite of his own unskilled conduct of his life. On the other hand there are those whose physique was originally poor, who have been so carefully tended and whose behavior has been so satisfactory for their own needs that health is the result. Very few have constitutions immune to all environmental and other detrimental influences; and few have constitutions not capable of improvement.

If health may be achieved, it is well to inquire what methods are the most successful in achieving it, for the results depend very largely on the method employed. In all the things man learns to do, it may be said that one of three methods is used. The thing is accomplished either on the basis of instinct alone; or on the basis of training and habit formation; or on the basis of knowledge and considered action. It cannot be said that one of these methods is invariably better than the other. In some instances one method is the method par excellence,

whereas another set of circumstances makes another method better What is necessary is to give instinct free reign at times, at other times to rely upon habits that have been established, and in still other circumstances to call upon knowledge. On many occasions in the life of adults only the possession of knowledge renders an individual capable of meeting a situation adequately.

Those who believe instinct to be a sufficient guide to health may assert that since self-preservation is subserved by instinct, instinct must therefore be all that is needed. It is significant, however, that the well-developed instincts of the baby are not relied upon for its up bringing. During many years the care given the young involves guidance of its instincts at many points. This requires knowledge on the part of the mother, for her instincts are not considered suitable substitutes for those of her child. Valuable as it may be in many respects, the world has come to the recognition of the fact that the maternal instinct is not sufficient in itself, but must be supplemented by knowledge regarding many matters—such as, for example, the purity of a milk supply.

There are those, however, who grant the necessity for knowledge in bringing up the young, who yet feel that these same young when adult years are reached may be left free to follow instinct thereafter. This would perhaps not often be so stated in words, although it is very often exhibited in conduct. Those who consider instinct an adequate guide, who want always to do what they "feel" they should do at a given time, and do not wish to be hampered by any knowledge of body needs, sometimes call attention to the savage, who knows little about health and yet gets along very well. Presuming that this is true (and all statistics available regarding primitive tribes seem to indicate that it is not) it would not indicate that their ignorance was responsible for their health and long life, or that their instinct unmodified was better for them than instinct plus knowledge would be.

The reason that instinct appears to be a successful guide for savages is partly that their environment is so much simpler that far fewer opportunities arise for making choices of behavior and getting into trouble because of the wrong

choice. Instinct speaks more clearly and unequivocally in such an environment. It is true that instinct does warn against many dangers, and does provide for self-preservation in many ways by making the saving thing the easy and agreeable thing to do. That instinct does so much, leads some individuals to expect it to do more. Yet to suppose that following instinct in all matters is going to lead to a satisfactory life in the circumstances in which modern man finds himself is equivalent to asserting that the brain need never have developed at all, so far as health direction is concerned. In the environment created by man's brain, only the continued use of the brain, to modify at times the adjustment to this environment, will enable the individual to survive.

In regard to the choice of food, for example, it is to be noted that the thousand and one varieties offered to modern man offer also a thousand and one chances for error in selection of quality and proportions of food. Appetite, or the nutritive instinct, loses its validity in the presence of food that may be chosen from so wide a variety of foods that intrinsically or in faulty combination may be injurious.

Modern man is not content as is the savage to follow pure instincts. His instincts become dulled, perverted or ignored in the presence of conflicting conscious motives leading in opposite directions. It is even possible to ignore the instinct of self-preservation, when strongly influenced by other instincts. Man eats, drinks, wears and generally behaves on the basis of that which may be in direct opposition to the instinct of self-preservation. Although instinct is a poor enough guide in modern environment, following it would be better than setting it aside in favor of behavior that, from the point of view of health, is totally unguided.

The dangers the savage finds about him are chiefly those of nature, of which instinct often very clearly warns him. In civilized life, however, there are many artificially produced dangers—such as the third rail, for example—against which no instinct possessed by man or animals would be a guide. There are certain aspects of the environment man has devised about which man must have knowledge. In other words, in a state of nature instinct may be relied on with some degree

of safety, although even then the wisest and most observing of the primitives no doubt come off rather better than the foolish ones.

That savages survive at all is due to the adequacy of instinct in a natural environment or in one modified only by their own efforts. There is thus a balance between environment and natural survival ability that is quickly upset when the man of nature is put into the elaborate environment created by the man of modern civilization.

This point is dwelt on because it is often said that Nature (meaning presumably the inherent living ability of the body, guided by instinct) will take care of one. "Back to Nature" and "leave Nature alone" are phrases frequently heard. Since man cannot go "back to Nature" in respect to environment, it is illogical to go back in respect to behavior. Old ways and modern times do not fit. Whether we will or no, behavior must take cognizance of the conditions in which behavior takes places. Behavior on the basis of instinct alone may not be safely relied on, even if one were willing to be guided by it implicitly, which is far from being the case even with those who account for their inattention to health on the grounds that they are following instinct.

It is true that physiological processes conduct themselves to a considerable extent automatically or reflexly. But the difference between health and the lack of it is often the difference between knowing how to aid nature or ignorantly going counter to natural processes. At crucial points the knowledge made available through centuries of painstaking observation makes discriminating choice possible. The use of knowledge should not be considered as a thwarting of instinct. It should be looked upon rather as a method of supporting the main instincts for personal survival and race preservation.

Self-preservation is made more successful in humans because of the long period of infancy and childhood, during which time the needs of the child are cared for by adults. This time of protection is also utilized for the purpose of training in habits that conduce to health and the preservation of life—a technique of living that is not based on personal knowledge. An individual brought up carefully will have many desirable

habits that will serve him well in many circumstances of life. Habits, however, are for usual circumstances. The unusual always demands, if it is to be well met, adaptations based on conscious consideration of the new factors and a conscious, wise choice.

If conditions could be counted on to be always the same, behavior could be permitted to take place always on the basis of habit. This would be a far simpler mode of living, for no reasoning would be called for. Even as it is, there are many constantly recurring conditions that may be met in habitual ways. Wherever behavior may be put on a reflex basis, the conscious mind is relieved of the necessity for making choices, and is therefore free to engage itself with other matters. In fact the aim of hygiene is partly to establish many automatically acting health reflexes. That these should be good reflexes it is, however, necessary that somebody have knowledge of the conditions—in adult life of course that somebody being the individual himself.

Knowledge should underlie reflex habit formation, but more particularly should it underlie the constantly recurring situations that are not suitable to be reacted to in habitual ways. Thought is required for such circumstances, and thought requires knowledge. One cannot reason soundly without some facts to hold up against each other. One is at the mercy of every new situation unless one can call up knowledge that may be pieced together to solve the problem involved.

If actual knowledge is needed to supplement instinct and good habits, where may that knowledge be obtained? The school of experience still supplies by far the largest amount, and will do so until it is realized that that sort of knowledge must usually be paid for at an extravagant price. This is as true in respect to matters of health as in respect to other matters. The "trial and error" method consists, as the term indicates, of a trial "in the dark," so to speak, followed by failure at first. It may result in correcting one's procedure and ultimately learning the solution of the problem involved, perhaps. But the problem may never be solved by such haphazard methods, and the lack of satisfactory solution may, in health matters, meanwhile bring disastrous con-

sequences. The technique of healthful living in particular is not likely to be learned in this way. It is possible to "pick up" the knack of living healthfully as one picks up other knacks, such as playing the piano by ear, or running the typewriter with the forefingers. It should be readily agreed, however, that the best technique cannot legitimately be expected by such means. A skilful or artistic performance in any line necessitates some degree of comprehension of the nature of the task, and usually much intelligent practice. Particularly is this true in respect to conducting the life in such a way as to achieve health.

If a problem is to be solved on the basis of knowledge, the knowledge that is available may be merely that involved in a consideration of past similar instances. In order to have enough memories available to use in selecting a wise course in any emergency it would be necessary to have had very many experiences and to be able to recall them all at need.

When variations from habit are needed, the knowledge of principles, rather than of separate instances, becomes of the most value. A single principle, based on many experiences of many men, embodies the material with which to reason logically and soundly. Principles may be applied to all sorts of situations; whereas reasoning by analogy fails unless the two situations are quite alike.

Valuable as instinct is as a foundation for self-preservation, valuable as good habits are, both fail occasionally to serve the purposes of all individuals except those in the most restricted environment. Valuable as experience is, it also fails at times, and at other times may be too costly. It is not clear why any individual beyond the stage of supervision by intelligent parents should hope to be able to have the best health without knowledge of the conditions that make health and those that break it. It is generally thought by physicians that it is not in rare occasions that such knowledge is needed, but that it is needed by adults, if the best results in health are to be secured, almost every hour of the day.

are the senses.

B.

CHAPTER IV

THE STUDY AND PRACTICE OF HYGIENE

Herbert Spencer, many years ago, made probably the most important contribution in modern times to educational theory and practice regarding the teaching of sciences in schools and colleges. He classified the various sorts of knowledge according to their value for life. At the head of the list he placed the knowledge of the means of self-preservation. This he described as of intrinsic value. He was not the first to call attention to the necessity for knowledge regarding the conduct of life. Hygiene was taught even among the ancient Greeks. The term is derived from the name of the Greek goddess of health, Hygeia.

During the centuries preceding Spencer occasional educators had recognized the necessity at least for training in health habits. Since his time other educators have carried his theories still farther. But at the time he wrote his essays on education, and made his first attempts to revise the English school curriculum to include the giving of knowledge of the means of self-preservation, the educational world was aroused to bitter argument. This was because there still persisted that strangely one-sided attitude engendered during the previous centuries regarding the preëminence of the soul and the mind over the body. It is hard to understand why a civilization that began so brilliantly in ancient Greece could have so completely forgotten its earlier wisdom. Yet it did so. The respect for the body, which seemed so entirely natural to the unfuddled thinkers of those days, lapsed into ignominy. It is appalling to think of the waste of human life and comfort and achievement through the many centuries when the body was scorned as unworthy and health considered almost incompatible with greatness of mind or character.

Having finally emerged from the fog that surrounded even the nineteenth century, the world is beginning to realize to

the full that health education is perhaps the most fundamental of all sorts of education, in that continued existence itself may depend on it, and that the highest achievements in health, and therefore in most aspects of life, almost inevitably depend on it. Hygiene is therefore at present quite generally taught in schools and colleges, sometimes being the only required course.

Hygiene is taught in different ways to individuals of different ages. The health education of children should properly involve primarily the formation of good health habits. When adult years are reached, the habits that have been formed under the direction of parents and teachers and have served well during childhood do not continue to meet all situations. New conditions arise that make difficult the preservation of habits already learned, and perhaps make some of them unnecessary. They must be modified or perhaps wholly revised, and new habits formed or new occasional circumstances met in entirely new ways. While the conditions of life are changing, the ability to comprehend and to reason has increased, a certain definiteness of purpose arises and a certain force of personality. A course in hygiene for adults should therefore consist primarily of information within the limits of comprehension, upon the basis of which experiments may be made, experience collected, reasoning take place, and future conduct be governed.

The information that is needed is derived from the biological sciences of anatomy and physiology, to which many other sciences, including particularly chemistry and physics, contribute.

Hygiene itself is an applied science. It utilizes the knowledge supplied by other sciences to form a science quite different from any other. It is the result of the study of the working of the body under different conditions, the comparing of results, and the determination of the ways of living that conduce to health in different circumstances.

Hygiene is applicable to all individuals at all times, both in sickness and in health. Although hygiene is utilized largely for the prevention of disease, it is also utilized in the cure of disease. The ways of living during illness are as important

as those in health, and often as important as the medication used in illness. Many serious illnesses depend for their treatment far more on hygiene than on medicine. This is particularly true of tuberculosis, but is also true of such diseases as typhoid and pneumonia. It is a commonly recognized fact that in colds, for example, sleep and rest, free elimination and suitable diet have an important relation to quick recovery. Hygiene, although important in preventive medicine, is not synonymous with it.

Fig. 6.—Mortality from tuberculosis (all forms) per 100,000 persons, in Massachusetts, 1857–1920. (From Moore, "Public Health in the United States." Published by Harper & Bros.)

There are few rules or laws of hygiene that have universal application. There are so many practices that are compatible with health that hygiene does not say that everyone must do thus and so, but will only indicate what the facts of anatomy and physiology are, what has happened in many or most cases, and what is likely to happen in all cases. It has been determined that ways of living that are fatal at times at other times are harmless; and that what injures one may actually benefit another.

In some few respects it has been discovered that a given procedure is invariably disastrous to health. The few universal rules of hygiene depend thereon. Didactic statements are made on these points. Didactic statements are also made regarding the results of certain sorts of behavior on the average individual. These may be called the general rules of hygiene. There are many respects in which it is known that the vast proportion of individuals are alike. Guiding principles exist, which it is safer for everybody to follow more or less closely.

Sets or codes of rules of hygiene have been drawn up and presented to the public time and again. There is no necessity here for stating them, for they must be thoroughly familiar to all who have reached the age of college students. They are better than no rules, for they do indicate what the average individual should do. If one suddenly came to life in adult years they would be valuable as a starting point.

Such sets of rules are valuable also as a gauge of one's correspondence in habits to the usual habits of those who are well. Any special deviation should be investigated. One should not conclude that the rules are at fault if they do not seem to apply in a given case. If an individual finds himself in good health while departing in practice from the rules, he should question the validity of his own health first. He may not be so successful in maintaining his health as he thinks he is. It is possible that he is entirely normal, but does not happen to be like the average in his hygiene needs.

Sets of rules are somewhat misleading in that they seem to make healthful living too simple a matter. They are also misleading because health is sometimes possible without conforming to them. Finally they are sometimes misleading in that observing them does not always produce results. No set of rules should be followed blindly after it is clear that the rules do not work. The codes or rules sometimes say "get eight hours of sleep." This is the average among well adults. If one seems to require more or less, it should be looked into. Ideally, the general rule should read "get *enough* sleep, whatever that amount may be."

In the subsequent chapters of this book there is very little that is stated as universally applicable. Even the advice to get exercise will be qualified by the term "appropriate." Therein lies the field of study and practice of hygiene—in determining what is appropriate in the individual case.

The most rigid rules of hygiene are those that are made for individuals after individual study and experimentation. Because there are few universally valid rules, it must not be concluded that there are no rules of hygiene. The point is that its rules are personal rules. There is nothing more personal than personal hygiene. On the basis of the general principles mentioned each individual should observe himself and make standards of conduct that for him give the best health results. It is only by careful study of an individual that his own personal health laws may be laid down. After they have been determined, they are not rules of hygiene in the universal sense, and applicable to everybody, but are rules for the particular individual at that particular time, and as definite for him as universal rules, although only personally and perhaps temporarily applicable. In this sense there are as many laws as there are persons and acts.

It would be easy to conclude from what has been said about its lack of validity of a general sort that hygiene is a vague matter. It must necessarily be vague when it is general. But in respect to a given individual at a given time and under given circumstances there is always a law that governs the relation of cause and effect. In this respect it is not vague, but most particulate. It is a question of finding out in a given instance what laws are in operation, and getting into harmony with them.

The particularly applicable law is as inviolable at the point of its application as are the laws governing the motion of the planets. They are in many respects as calculable. What makes the maintenance of health so difficult is that in ignorance a perfectly established law may be working harm without one's knowledge.

Whether one knows it or not, every act is either in accord with the particular law of physiology and hygiene applicable at the time, or it is not in such accord. Regardless of one's

knowledge the laws go on working in their individual application. Penalties are exacted just as certainly for being out of harmony with the laws, whether knowingly or unknowingly. Disease, discomfort, disability or death come to those who break their own laws of health.

This does not mean that harm follows breaking the laws of health applicable to somebody else, or failure to live in a way that produces health in somebody else, or failure to follow codes of health drawn up for the average. It means that failure to adapt to given conditions, because of lack of awareness of the conditions or lack of the wish to adapt, produces

Fig. 7.—Proportion of drafted men classified as defective and proportion rejected, 1917–1918. (From Moore, "Public Health in the United States." Published by Harper & Bros.)

inevitable results. They may be unobserved or postponed but they are inevitable.

Denial of the existence of the physiological and hygiene needs of the body does nothing to block the connection between cause and effect. Ignorance of the needs of a situation does not excuse; least of all does the denying of the existence of health needs excuse. All illness indicates lack of conformity to the body's needs. Much illness indicates ignorant or wilful or stupid lack of conformity. The study of hygiene should

result in the limitation of much of the ill health due to ignorance of personal needs and of the method of meeting them.

Since there are some laws that are universal, these may be definitely stated, and no one need go without knowledge of them. But since most laws are personal ones, it is up to the individual to find out what they are in his case. This involves experimentation.

The experimental method on the basis of principles is carried on by most sciences. In hygiene laboratory work is also done. In the case of the college student the laboratory work of personal hygiene is the individual's own daily life. It is in one's own living that one applies the principles of physiology and hygiene, making experiments on the basis of the principles, observing the results and reaching individually applicable conclusions. The conduct of life as it goes on from day to day, directed according to established principles, furnishes finally the set of rules that thereafter will serve as the basis for living by that individual.

Some experiments should not be made because they are doomed to failure. As has been said there are some ways of living that are subject to universal laws. There are some things that no one who wishes to preserve health and life will do, because well-established knowledge shows them to be invariably fatal or damaging. Certain unusual sorts of behavior are recognized to be always damaging—the taking of certain poisons, for example. But it is not always recognized that ordinary acts of everyday life may, for a particular individual at a given time be as inevitably damaging as poison. Such a generally good procedure as the taking of exercise may even fall into the category of damaging behavior in certain bodily states.

Not all kinds of experiments are legitimate fields of voluntary investigation. Accidental or unwitting experimentation has proved too definitely that disaster follows. It is important to know what these inevitably unsuccessful experiments are and to avoid them, for some of them seem as harmless as would the igniting of nitroglycerine to the uninitiated.

Since the results of risky hygiene experiments do not always follow as dramatically as the result of the chemical experi-

ment mentioned, it is easy to be misled into underestimating the results, until the accumulated effect in a long-suffering body rivals an explosion in disrupting life. An effort will be made to point out lines of experimentation in living that would be likely to result either at once or in time disastrously.

Whereas we prefer to speak of the positive and beneficial effect of good hygiene in producing good health, there are those who are much more interested in the negative aspect of hygiene, and are aroused more by fear of disease than by hope of better health. A knowledge of what the penalties are likely to be and how soon they will appear is valuable. By the aid of such information, one may compare the expenditure for health not only with the advantages to be gained, but with the harm to be avoided. The individual is free to weigh the advantages against the disadvantages of certain procedures, so long as he does not interfere with the well-being of others either of this generation or of the next. But he should make his decisions on adequate knowledge of the relation between cause and effect.

On the other hand there are many experiments that may safely be performed, and that should be performed by each individual in order to determine what procedure in him produces the best health. No two individuals need exactly the same hygiene procedure.

The aim is to find out by experimentation both how much and how little expenditure of effort is needed to keep health at the maximum. No one wishes to pay too much in time or thought for any of the advantages of life, even for those of health. But neither would most people knowingly care to pay too much in the coin of health for the joys of life that cease to be possible if health is gone. Experimentation with a view to getting the best health with the least conscious effort is entirely justifiable.

Experimentation in order to be really that, and not merely stupidly haphazard living, must be on the basis of knowledge of the materials with which one works—in the case of hygiene, of the body and what affects it. The fuller the knowledge the more successful the experiment is likely to be. The whole experiment of living is made safer and the results more

certain if there is in advance a concept of structure and physiological processes, that supplies suitable premises on which to experiment.

The study of hygiene involves, then, the acquiring of certain knowledge and putting that knowledge to personal test.

Since the purpose of a course in hygiene is the acquiring of the technique of living, only that amount of anatomy and physiology will be included that contributes directly to that end. These sciences are related to hygiene somewhat as the science of motor mechanics is related to driving a car. One may be skilled in one and not in the other. Logically one would expect to find some relation between the two. Actually there may be none. Surprising as it is, one may be thoroughly equipped with much knowledge of biology, even of medicine, and never develop skill in living or hygiene technique.

It is plain that knowledge is not all that is necessary for health, nor inevitably successful, nor the only road to health. It is possible for those who have little knowledge to be in very good health, for the reasons already suggested (the adaptive power of the body processes, the guidance by instinct, the regulation of life by good habits, and the learning by experience). This is particularly likely to be the case if the constitution was good to start with, the individual observing and honest with himself, having respect for health, encountering not too many trying or unusual circumstances, and having rather frequent medical advice. Even for these health is not on so firm a foundation as it would be if they knew more.

That the most learned are not invariably the well, that those who have the most knowledge do not always achieve the most health, is not an argument against the possession of knowledge, but against merely possessing it, and failing to use it. A gap between knowledge and practice is always to be deprecated, but does not prove anything except the difficulty of coördinating thought and life.

CHAPTER V

INEFFECTIVE ATTITUDES TOWARD HEALTH

Since health is generally admitted to be desirable it is remarkable that so many individuals fail to attain the health they desire. As has been stated, this is due partly to failure to accept whole-heartedly the rational proposition that efforts based on knowledge offer the soundest foundation for the hope of health. This failure to appreciate knowledge is determined by various ideas, strange quirks of the mind or personality sometimes, differing in different individuals, so dominating the mind, however, as to exclude the possibility of an impartial view of the relation between knowledge and health.

It is not fair to assume that the intelligence is always at fault when health and the knowledge of hygiene is not appreciated. Sometimes it is true, however, that in such cases the intelligence is not of the highest order. The individual may be able to learn, but real intelligence involves more than being able to absorb facts. In fact it involves chiefly the ability to make adequate solutions of problems. The highest form of culture involves even more than that; it involves the ability to find the real beauty in the world and in life. Much of the failure to appreciate health and to achieve it is due, however, not to weakness of mind but to emotional attitudes and temperamental defects. The affective, or emotional, aspects of life nullify the rational. Various feelings and wishes overrule the intellect. For one reason or another hygiene teaching may be considered either unnecessary, a waste of time, boring, unworthy, beneath the attention, futile at best, or possibly positively injurious. It is desirable to consider some of the types of individuals whose attitudes are unlikely to lead to the securing of health.

In the first place there are those who consider hygiene education unnecessary. The difficulty usually is that such individuals are unduly optimistic about their health. They are satisfied with the present state of their health, and maintain that one gets along very well without attention, or at least

without knowledge. If such is actually the case and the individual is well, his optimism to a certain degree is understandable. What he often fails to realize is that his good condition is probably due to knowledge on the part of somebody at some time, and that the continuation of his good condition will be in proportion to the continued knowledge applied to it.

Often the individual who is most satisfied not to pay any attention to his health, thinking he is "getting along very well," is not really doing so, if judged by genuine health standards. Such an individual may boast of his ignorance and declare his intention to remain so, while going about in a state of health that is obviously defective in the eyes of others if not of himself. Such individuals are mentally myopic in that they can see but dimly the state of their own health and the implication of health knowledge. They may even admit all sorts of ailments—such as frequent colds, headaches, and lack of endurance—but fail to see that these ailments incriminate their health.

Among those who consider formal teaching unnecessary are those who think they already know enough about themselves to care for themselves well, even though they know nothing of physiology and hygiene, or at least only what they have "picked up." One has naturally a very special interest in his own person and anything that concerns it. It is natural to feel that one "knows better than anybody else" what is good for one, and to resent interference. The apparent subjective validity of personal opinion about one's self is usually unsound, however, unless it is based on wisely conducted experiments according to principles.

To rely upon subjective feelings too completely frequently means living in an imaginary world. Opinions about one's self in particular are likely to be fictitious. To guard against mistaken notions it is necessary to check up with facts frequently. Any opinion formed without reference to things as they actually are, or formed on any basis except the combining of all the best available evidence is likely to be an erroneous opinion. The individual who, without knowledge of anything pertaining to health, is yet sure that he "knows how" is not on the right track. He is likely to be opinionated about other matters too, and to disregard other important knowledge from

without. The extreme of this trait involves delusions that have no foundation in fact. To a lesser degree the individual who feels that he has knowledge from within, superior to any that may be gotten from a study of the objective facts or from others, is somewhat deluded. It often leads not only to lack of interest in hygiene teaching, but even to the rejecting of medical advice in illness.

Those who think that hygiene teaching is futile seem to believe that the ways of living do not amount to much in relation to health. They respect only the big things that influence health and fail to see that daily life offers as great and far more numerous opportunities to injure or improve health. They are able to respect medical science in emergencies, but do not see how it can be of any use to them in everyday life. Those, however, who have experimented wisely a bit, on the basis of a knowledge of principles of health, know how slight a change in living it takes to make all the difference between health and ill health. It is not uncommon to hear individuals say that it seems hardly worth while to go to a lot of trouble to learn about the body when it is necessary to rely on physicians anyhow if one falls ill. But physicians do not live one's life for one, and it is in living one's life that health is made or marred.

There are those who think that hygiene teaching is futile because the status of health for them is already determined by factors outside the individual's control. Often such individuals are not well and are seeking to place the blame on others than themselves. Perhaps they do not themselves deserve the blame, but more often than is realized the individual's attitude is at least partly the reason for his ill health.

There is a tendency, for example, to attribute poor health to Providence, or Fate, or bad luck. Still more frequently do individuals offer the excuse that their health is in certain respects irrevocably determined by heredity, and that, therefore, no personal efforts would avail. While inheritance is responsible for placing certain limits beyond which the individual can not go, there is no reason to anticipate in advance that the limit is necessarily low, and that the application of knowledge will not change conditions. A fatalistic attitude about health certainly does nothing to help an individual to reach his own limit, at all events. At whatever constitutional level

one starts, there is always some possibility of making the constitution better or worse by what one does. If no attention is given to making it better it may become better as a result of favorable conditions, but experience shows that without deliberate attention it is likely to become worse.

Those who are unreasonably pessimistic about the possibility of gaining health through knowledge are as unjustified in their attitude as those who are unreasonably optimistic about getting along without attention. Weaknesses are seldom "outgrown" without attention; with attention on the part of the individual they often are.

The fatalistic attitude may not be based on a belief in the ineradicable result of heredity but of early circumstances and environment. Adverse conditions in the previous life may make health harder to get and may limit the degree obtainable, but there is no knowing in advance, in many cases, how much improvement may be made by the intelligent efforts of the individual in his daily living. Of course it is to be understood that in impaired states of health medical attention, in addition to the efforts of hygiene, is usually necessary.

There was formerly an attitude of fatalism about the health of women, and about various special ages when it was thought that no efforts of hygiene and few efforts of medicine would avail. It is now known to be quite a fallacious notion that there is any age when healthy living is futile, or that women are doomed to ill health no matter how they live. Hygiene, even more than curative medicine, is responsible for the expectation of health by women as by men, and at all ages for both.

There are those who believe that knowledge of conditions ought to help health if such knowledge were available, but that actually no practical knowledge can be found. The difficulty here is usually that the individual has been relying on the sets of rules that apply to the average person and do not suit his own needs. Hygiene teaching is, therefore, for him discredited. He observes that doctors disagree, that the sets of rules do not correspond, and that none gives him health. He has probably tried a number of health cults with the same result. His natural and logical conclusion is that the whole matter is unknowable, and that there is no sure guide even

for one who is genuinely interested. This sort of individual will find, by learning about the body and making his own experiments with the aid of an experienced consultant, that the subject is not so hopelessly befogged as he had thought.

Physicians do disagree, according to their own observation, about the effect of certain procedures in the daily life. When speaking of the average man there is opportunity for considerable difference of opinion. But the wise physician does not make arbitrary rules for all, based on observation of a few, or even of very many, cases. What he does do is to suggest that a given procedure be the starting point, because, not only in his own opinion but in that of most observers, it is most likely to work out well.

If one resorted to general advice from sound sources only, general advice would be found to be much alike regarding behavior suitable to the average man. It is chiefly because of the prevalence of unsound advice that there appears to be disharmony in science; or because general advice is taken when personal advice is needed. Although general advice regarding hygiene often does not work, it should be noted that it fails because no particular individual is under consideration. If individual advice regarding hygiene is secured it will usually be found that there is much harmony among well-equipped physicians.

General scientific opinion does change from time to time because investigation is always going on and sciences are growing. This is not a fault, naturally. The desirability of following only recent, thoroughly accepted opinion is apparent.

There are those who consider the study of hygiene harmful to the degree to which laymen study it, quoting that "a little knowledge is a dangerous thing." This is so only if the little knowledge is mistaken for full knowledge, and used as an adequate basis for action in all circumstances. If one does not know how to play the piano, one does not attempt to play a complicated sonata. But whether one knows how to conduct life hygienically or not, one does conduct life. Since the action is performed anyhow, it is wiser to back it up with sufficiently full knowledge to make the performance as successful as possible. Even a little knowledge is so much to the good. Living is not like playing the piano, that may be

done or not according as one has the knowledge to do so. If it were obligatory to play the piano, most people would feel the necessity of learning how to play it.

One of the most desirable results even of a little knowledge of the body is that it enables an individual to comprehend its intricacy and its modifiability, and its adaptability, and its need for care by the individual day by day, and its need for expert care upon occasion. Those who know nothing at all of the body are likely to expect too much of it, as has been shown. On the other hand, they are likely to expect too much of treatment, particularly of cults and quackery. Disappointment is likely to attend either form of false expectation. If left too much alone the body disappoints one in its adaptability, and if the body becomes disordered even the best of treatment may disappoint. Knowledge should be of value in proportion to the amount, even a little serving better than none. If a man has a little knowledge and knows it is a little, and knows to what degree it may be relied on, he is better off than the totally ignorant man. It is better to be able to add and subtract even though one leaves calculus to others.

Those who think a little knowledge is dangerous sometimes refer to the apprehension engendered by even a general concept of how "fearfully and wonderfully" we are made. If anxiety is aroused by the knowledge of the working of the body it is likely to be because the individual was in a state to be anxious about almost anything. A wholesome respect for danger is quite different from apprehension regarding it. One who is relatively normal does not find any ordinary discussion of the body terrifying, and he necessarily, unless biased by his own anxiety state, will learn much more to reassure him than to frighten him. An individual who is slightly abnormal in being subject to fears of various kinds usually includes the fear of disease, and often makes it his main fear. This is not an argument against the knowledge that to most is reassuring and helpful, but against the anxiety state that makes useful knowledge a source of alarm. The mental attitude needs attention in such a case, to correct the tendency to haunting fears and obsessions.

It is generally observed that knowledge tends to drive out fear. It is the manifestations of the unknown and the mys-

terious that cause alarm even in the adult. But adults normally are not as timid as children because they know more of themselves and their environment. Somebody has said, "To know what to fear, is to know what not to fear."

All increase of knowledge should help to do away with worry and uncertainty. In any performance the one who knows how and is certain of his technique is less likely to be haunted by fear of failure. The ignoramus who is stumbling along in ill health is the one who is worried, often depressingly so, at every new sign of what a wiser person might recognize as trivial. If one knows something about why heads ache one is less likely to be apprehensive about "brain fever," but more likely to get rid of headache by suitable measures. The informed person often recognizes readily the result of lack of skill in the technique of health maintenance, and seldom gets into a panic. The attitude of the individual educated in health matters is a calm confidence in daily living and even in the emergencies of living.

To those who are prone to think of the soul and the mind as preëminent and unassociated with the body, any interest in the body is likely to seem unworthy. If such a differentiation between the various aspects of life were possible, it might be granted, even by the hygienist, that bodily health was an unworthy aim if it ran counter to the other aims. But it does not; in fact, it tends to run parallel at all times. Whatever the aim, it is subserved by health. Body and mind and soul are inextricably one, whether one admits it or not. There is undeniably some justification, sometimes, for putting aside health considerations, but rarely completely and rarely for long.

There seems to be little excuse for the lofty minded individual who stumbles along through life above all mundane things, falling into all sorts of pitfalls, including those of health, because he denies the claim of "practical" knowledge in his search for culture. He is more likely than not to defeat his own ends, and his cultural achievements to fail for just that reason.

There also seems to be little excuse for the over-righteous individual who believes that giving time and thought to his personal comfort and safety savors of self-indulgence, or that seeking something for himself is a violation of his altruism.

There are individuals who profess to be, and actually appear to be, willing to accept what falls to their lot in health and in other respects—who are willing to surrender comfort, even life itself, to higher aims. To most, however, health to at least a moderate degree seems to be one of the conditions of service, and the development of the personal values of all kinds a prerequisite for the most effective service. Probably the mental attitude of the individual who is willing to sacrifice health to the service of others is not unlike that of the martyrs of old who mutilated the body "to the glory of God."

Exaggerated altruism also suggests as its underlying cause an extreme degree of egotism expressed in a roundabout way, the individual gaining much personal satisfaction from his self-abnegation. The balanced individual cannot fail to make the connection between the continuation of life and health and the furthering of his altruistic work. In fact, the most genuinely altruistic individual looks on his work frankly not as altruistic, but as the most complete expression of his own developed and adapted personality. In such an individual health would be considered as a part of the means of the development of the personality.

Those who seek the culture of the mind and the soul at the expense of that of the body, and do not see the relationship between them, are in the minority, but still are found in surprisingly large numbers among those who fail to get health.

The acceptance of ill health while wanting health is not infrequently found among those who are temperamentally of the stoical sort, or have become so by training. This tendency has been found rather frequently at all times and in all races, although its prototype is the Puritan. Such an attitude complicates a search for health because it involves an unwillingness to recognize frankly any departure from normal. Such individuals do not like to "give in" to an ailment or to seek advice about it. It seems a confession of cowardice and weakness. They call it "complaining" and abhor in themselves and others "making a fuss" over health.

To be sure, complaining may become a vice and may represent a distorted, weakened personality. The recognition of ailments normally represents merely the facing of facts. Emotional complaining, or the attitude of apprehension and

intense interest in symptoms, is quite different from intellectual recognition followed by action to meet the recognized need. To be sure a pain may not be a real pain, but it is likely to be, and is likely to indicate that something is wrong. No individual need feel that physicians at all events will consider him unduly solicitous if he recognizes minor maladies and symptoms, providing at the same time he makes a real effort to get rid of them. Even the individual who has much knowledge may prevent its being useful to him by cultivating the blindly stoical attitude.

It is not valor to bury one's head in the sand like the ostrich and believe there is nothing to see because one does not look at it: it is merely stupidity. Nor is it valor to carry on a losing fight when, by a change of tactics, it may be made a winning one: it is merely obstinacy The most valorous thing an individual can do is to look facts squarely in the face, whatever they may be; and the most discriminating thing he can do is to act as may be necessary on the basis of the facts.

Those of the stoical type guard with all their strength against falling into the tendency to hypochondriasis, or a too great solicitude about health and a too great dwelling upon symptoms of disease. It is true that this tendency in those about one is objectionable, and leads to health no more than the opposite attitude—that of ignoring symptoms. There is, however, a mean between the two extremes. At most times one should be thinking nothing about health at all, merely doing the things previously decided upon as suitable, while more or less unconsciously alert for indications for the necessity of giving it thought. When such necessity arises all the attention may for a time have to be centered about health. To do this occasionally is obligatory if the best health is desired. A rather intense, concentrated attention from time to time is what enables one to be so carefree most of the time. This may be done without any fear of becoming morbid about it. There is no more reason for expecting to become morbidly interested in the body, by giving it this type of attention, than there is for expecting to become morbid about one's other affairs, to which attention must be given. As has been said, those who become morbidly interested in the body are usually those who comprehend it least.

An individual may be hampered by having so great a respect for health that he is loath to class himself with the ailing, even to the extent of admitting that his health is not "perfect." This is particularly true among young women of the present generation, who have no sympathy with the languid and languishing Victorians. They frequently look askance at one of their number who shows an interest in the means of keeping well, as if she had frankly admitted an inferiority. Men have always had a tendency toward this attitude.

If there is inferiority of health, the frankness of modern times should lead to admitting it at the proper time and to the proper persons. But an interest in health measures does not necessarily imply any present inferiority. Many of those who are most well are so because they have given and continue to give attention to the matter. Individuals often forego the information and advice they might have because they cannot bear to admit any need of it. Furthermore, they may not wish a record of ill health against them, not realizing that seeking health advice is stamping one's self as intelligent and therefore as more likely to be well than are the heedless. Even insurance companies do not conclude that an individual who never has medical advice is necessarily therefore phenomenally well and phenomenally successful in guiding his own life. They, like industrial plants and schools and colleges, feel more certain of the health of those who are frank about the need for advice than about those who for one reason or another class themselves as having no health needs.

One of the most insidious attitudes that eventually precludes health is the attitude that one's duties and pleasures do not permit of taking time for meeting health needs. What deceives the individual into thinking his reasoning is sound is that neglect of health is often cumulative. For a long time no loss of health may be observable to the individual. Although such a person logically admits the necessity of health in order to keep up his activities, he does not as logically admit that health will not go on permanently without attention. If a person is too busy to give it this attention, he is usually too busy to be well or successful or comfortable or useful, even too busy to live as long as he might. In hospitals of all kinds are people who were too busy to give atten-

tion to the very factor that makes it possible to go on being busy. Enforced idleness coming after excessive activity is in itself bad enough to this type of individual, even if it did not entail discomfort, financial burden and worry.

The fact that one is able to be so very busy usually indicates that a fair degree of health was present at the start. That condition may last a varying length of time, sometimes even until middle age. But there are many "breakdowns" at that time due to nothing but excessive application to work or pleasure, and the associated neglect of hygiene. It is not borrowing trouble to anticipate a time when too great activity along any line, to the neglect of health, may lead to trouble.

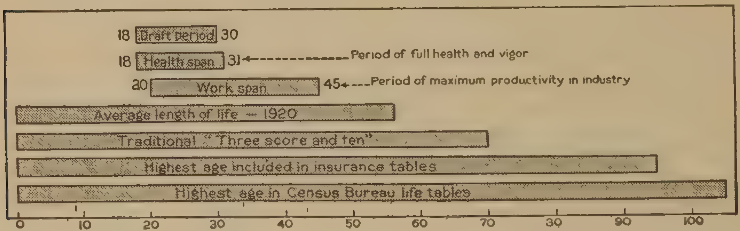


Fig. 8.—Period of life designated by the Life Extension Institute as the "health span" compared with other spans and lengths of life. (From Moore, "Public Health in the United States." Published by Harper & Bros.)

It need not entail apprehension, but merely a judicious use of caution. It is seldom necessary to sacrifice health considerations entirely, even for short emergency periods. There is at present so much respect for work that even an amount absolutely detrimental to health is considered to a person's credit, rather than to the discredit of his intelligence.

The cost of health in respect to time varies with different individuals. To Roosevelt and Annette Kellerman it cost a great deal in time and effort. Health seems to be given away to some, but it will often be found that those most gifted with health have consistently made the most effort and almost religiously have devoted sufficient time to it. The price the actress and the athlete, for example, pay in time devoted to health maintenance frequently appalls those who expect to become perfect specimens without doing anything to become so.

The person who is too busy to attend to health is often the one who, when he does make an effort, is impatient regarding

results. Realizing that health needs some attention, possibly after it has already begun to be impaired, he may plunge into violent efforts to correct the defect, and then give it up as suddenly as he began, if, after a month or two, he does not note a great change. This shows a total lack of understanding of the ways of nature. Theodore Parker once said, while working with might and main for the abolition of negro slavery, "The trouble seems to be that God is in no hurry and I am." The individual who finds health waning is always in a hurry to have it restored, but he often fails to realize that the condition in which he finds himself is the product of a considerable amount of time—months or years perhaps—and that it is likely to take an equal length of time to correct the damage, if it may be corrected at all. If there were no marvelous instances of slight changes in habits quickly producing results, the impatience would be ridiculous. As it is, one should hope for speedy improvement, but be prepared for a rate of gain in proportion to the rate of loss.

Less noble qualities than some of those mentioned have a part also in interfering with the gaining of health, even though it be desired superficially. Many temperamental traits make for ill health very naturally and logically. For example, a tendency to self-indulgence in the joy of the moment, and an inability to deny one's self present pleasures for the sake of more remote ones, or ones less clearly seen if not more remote. Even those who wish to be able to indulge themselves to the full in all the joys health makes possible sometimes see the future goal only dimly in the presence of momentarily clamorous wishes. This is clearly illustrated in the case of those who indulge themselves in pleasure to such a degree that more pleasure, even of the same kind, is impossible. It is equally possible to over-indulge in work, so that neither more work nor more pleasure is enjoyed. A very common sort of self-indulgence is represented by dietary indiscretions that interfere with comfort, appearance, and efficiency. If one cannot forego the wish of the moment, it is time to give up expecting health and what depends on health, including most of the satisfactions of life.

Vanity is another trait that leads to defiance of health principles. It is justifiable to take pride in one's self, and the

wish to do so does not run counter to health: but vanity often does—in that it uses superficial or temporary sources of pride to feed the self-respect. Among instances of such vanity may be mentioned that which causes an individual to become dangerously undernourished in order to be ultra-fashionably thin, or to refuse to wear "disfiguring" glasses when they are necessary in order to save the eyes and the nervous system. The subsequent humiliation at having so far succumbed to vanity as to injure the health is often as painful to such an individual as the ailments thus induced. If the results of such practices were labeled as due to this cause, perhaps even the most vain would seek more successful ways of gratifying vanity.

Procrastination is another defect of temperament that interferes with health as with many other achievements. Putting off the time when one will begin to "do better" leads to putting off the time when one will begin to enjoy better health. This trait is often associated with self-indulgence—for example, in such instances as putting off the visit to the dentist. In health matters while one is procrastinating the conditions in the body go on. Unless one is fortunate, that which is going badly is likely to go worse while one delays.

Finally, there must be mentioned the attitude of the gambler, which is perhaps as common as any other among those who trifle with health. It implies a hope that, according to the law of averages, what one does may not turn out badly. What the individual usually says is that he knows the probable penalty for his particular kind of health misconduct, but that he is willing to pay the price. What he usually means is that he expects he will not have to pay. If it did not sometimes happen thus, there would be little heard about being willing to pay the price. There is seldom complete certainty about the physical results of various sorts of behavior. If the outcome could be definitely known in advance—if the results of certain acts were certain, apparent and immediate—there would be no need of emphasizing the value of knowledge of the body. The whole world would have learned long ago how to keep well. Since the result is often delayed, bearing no relation a layman can see to anything he has done, there will still be those who base their reasoning on such

instances and hope for that which is not legitimately to be expected—freedom from the results of given causes.

In science results may be computed sometimes with mathematical exactness. In medical science a definite outcome

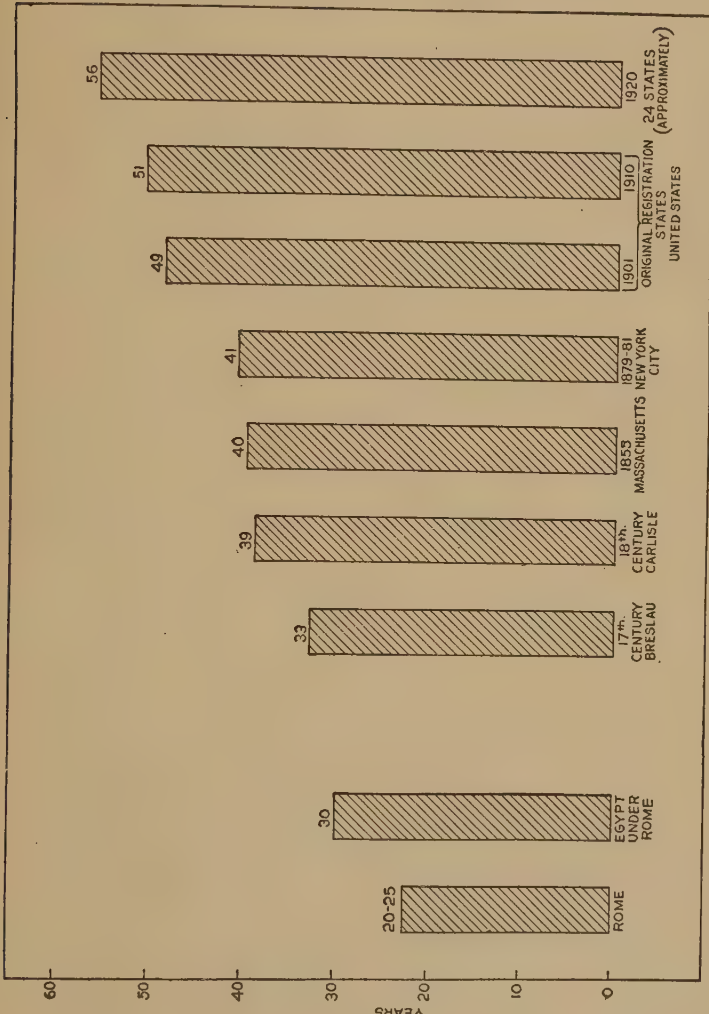


Fig. 9.—Increase in average length of life, based on representative life tables. (From Moore, Public Health in the United States." Published by Harper & Bros.)

cannot always be stated, even in a given case. Yet one thing leads to another so regularly in some respects that it is inadvisable to count on anything else. Whereas it is absolutely

certain that fire results when inflammable material is ignited, it is almost as certain that the person unvaccinated against smallpox will get the disease if exposed to it.

To defy certain health principles is often almost equivalent to betting against a certainty. On the other hand, there is a certain element of apparent chance in many health matters. It is never actually chance. If certain conditions prevail, certain results follow. But it is not always possible to know exactly what conditions do prevail within one's self or anybody else. One must take some chances; it is inevitable, since one must act without full knowledge of all conditions. There is, however, a vast difference between placing one's bet on what may justifiably be considered the winning side, and gambling blindly. What one supposes to be a fifty-fifty chance may actually be a thousand-to-one chance.

Many of the attitudes mentioned as interfering with the attainment of health, and others less common that have not been mentioned, represent frequently some degree of personality defect that needs attention not only for its bearing on health but on the whole conduct of life. This applies as well to those who are not interested in health at all as to those who are too interested in it, and to those who, although interested in health, fail to achieve it for reasons such as those mentioned. Not for all is health achievable, but for far more than is perhaps realized.

There is reason to believe that the next generation will see an increase in health even greater than that of the past twenty-five years, which was greater than that for any previous corresponding period available for statistics. Naturally the ignorant will continue to seek health in random, illogical ways, and will fail, unless someone watches over them from moment to moment, telling them what to do. The stupid and irrational will continue to be unable to see cause and effect in their proper relationship, and will fail of health thereby. Those of feeble and warped personality, while wanting health and perhaps knowing how to get it, will continue to be unable to do that which would bring it. It remains for those who can and will think, and are sufficiently stable to act accordingly, actually to achieve health.

CHAPTER VI

DISCERNING ATTITUDES TOWARD HEALTH

Aside from the knowledge regarding the personal daily care of the body gained through the study of hygiene, there should develop a point of view more discerning toward various health matters.

There should develop, for example, an ability to distinguish between health and the lack of it, so that no sub-maximum state will be tolerated any longer than it must be. Hygiene study should convince all of its students of the desirability of investigating any departure from health, and of not enduring discomfort or disability without finding out if it may not be gotten rid of and its recurrence prevented. There should arise a distinctly higher aim for health, and at the same time a more legitimate hope for its realization, and freedom from fear of its loss.

The study of hygiene should lead one to be wary of waiting for symptoms to pass off, even though experience shows that they often do. One cannot tell when they will fail to do so, or when, if they do, irretrievable harm may be done while they last. It should lead to greater willingness to have advice, even at pecuniary sacrifice. If the cost is expected to be more than one can afford, it will usually be found that it can be reduced to within one's financial limits. Both individual doctors and hospitals do more free work than is usually realized. No one need go without medical attention. Even though it does cost something, however, the cost of caring for illness is invariably less at the beginning than after illness has progressed. The study of hygiene should teach one to be willing, also, to sacrifice time and pleasure, as well as money, for the care of the health, for the same reason—in order to avoid later, greater sacrifices.

The study of hygiene should show one the folly of emergency living. Emergencies of any kind may be accidental and not

preventable by foresight, but usually they indicate bad management at some point. The fact that doctors have to have means of swift conveyance, and are given special consideration in respect to laws against speeding, is witness to the fact that individuals are prone to get into "tight places" from which they have to be extricated at a moment's notice. Emergencies are to be avoided because they are inconvenient in the first place; and in the second place because they involve more difficult health situations, from which recovery is less satisfactory than from situations that are met when trouble first threatens.

Hygiene should also teach one to distinguish between health practices and health fads and cults.

The health faddist is a pathetic object, because he is one with a good aim but a poor method. He is like one who is lost but trudging manfully along the wrong road. A wise man who is lost tries to find out where he is, and the best road to where he wants to be. Fads represent merely uncalculated procedure for many; for some they represent a search for a way that is a little shorter or easier than the way that a qualified guide would tell them was the best.

The fad for "physical culture," or Turkish baths, or vegetarian diet, or colonic irrigation, or Coué, or any of the health fads that sweep over the populace from time to time, become fads because of the success of the particular measure in certain cases. Those who are benefitted by them believe that everybody would be equally benefitted, and they convert others in droves—those who seek an easier way to health. There is no easier way than the right way, whatever that may be in the given case.

That many prosper on fads is by chance. Without guidance one may stumble onto the right road. Almost any forms of treatment that become fads may work well in the case of a certain small proportion of people, but it is equally true that they work badly with a much larger proportion of those who take them up. One may not legitimately expect cure by any measures that have not been determined, by scientific investigation, to bear a logical relation to one's needs.

Fads and cults are based on half-truths, guesses, happy thoughts, financial inspirations, or conclusions reached from a few cases. Many of them are propagated by those whose genius runs to money-making rather than to medical skill.

Even when a current popular treatment is urged on one by another who says he was cured thereby, it may be questioned whether the procedure cured him or whether nature cured him. It may even be questioned whether he is as fully cured as he thinks.

One thing has often been observed—that the fad that is taken up is likely to be one that accords very well with a personal preference of some sort; or that it is exactly the opposite of a preference, and represents a sort of penance. The individual who likes vegetables may become a vegetarian, although arguing that he is doing it for his health, because meat is not fit food. On the other hand, those who particularly dislike physical exertion are often to be found among the most ardent exercise cranks. Because he does not like it, one may feel virtuous while forcing himself to do it. The person who likes to have his body manipulated will be likely to take up the cults that glorify such manipulation into a system of treatment. Those who are particularly averse to facing reality squarely will be likely to take up cults that make a virtue of this weakness. The healing cults that entail denial of the reality of the body offer to such individuals just the justification they wish for their own inclination to flee from the recognition of the disagreeable. Temporarily they are thus spared the recognition that the health needs attention, and the responsibility for giving it the attention needed. Allowing one's self to believe that some sort of pseudo-magic will be more effective than hygiene and medical treatment usually represents a surrender to the emotions and an exclusion of facts. Many popular forms of treatment violate all scientific knowledge and make their appeal only to the fears and hopes of those who find the use of the intellect and rational action a little too difficult.

It is not meant that some of the more prominent cults have no cures to their credit; but that none, in the opinion of scientists, is sufficiently broad in its consideration of health, or

sufficiently personal in its consideration of individual difficulties. Any form of treatment that proceeds without a thorough, scientific diagnosis is unsound. No "cure-all" can possibly be rational, since not all individuals are alike or have the same ailments.

The chief danger of quackery and cults lies in the one-sided view of disease they hold; the chief advantage of scientific medicine is its inclusive view of disease and its inclusive methods of treatment. Scientific medicine aims to consider all factors and to use any available, sound means for treatment. It is true that vertebrae out of place will cause pain and disease, but it is not true that all disease can by any stretch of the imagination be considered due to such a cause, or appropriately treated by efforts to put the vertebrae back into place. It is true that the state of mind influences health to a marked degree, but it is not true that the mind causes all diseases or that treatment of the mind alone will suffice to prevent or cure any great amount of disease.

Even scientific medicine will occasionally find only one factor at fault, but it will not be the same factor in every case. Nor will it be stated that that is all that is at fault, in a given case, until after investigation of the whole problem has shown it to be so; nor will any one treatment be begun automatically for each and every case. If disease were as simple as that, there would be no excuse for illness; but it is not. Many kinds of scientific knowledge, applied in many directions, by both communities and individuals, are necessary in order to deal satisfactorily with the problem of disease.

Even though the individual wishes to have the best medical advice available he is sometimes puzzled about the choice of a doctor. It is noteworthy that the public as a whole has, through legislation, made it possible only for those with sufficient scientific training to be licensed to practice medicine. Yet it leaves the individual free to choose those who are licensed or those whom the state fails to recognize. In choosing a doctor the first consideration is that the one chosen shall be licensed to practice medicine. Of those licensed, it is then necessary to choose one who has had sufficient experience. It is not always the doctor who has the largest practice, however,

who is the most skilful, although this should be taken into consideration. It will always be found, if there is a hospital in a community, that some of the best equipped physicians will be on its staff. This is, for the layman, about the best available means of securing the names of able physicians. If a specialist is needed, or thought to be needed, it is usually better, although not always, to consult a general practitioner first. This is not only in order that one may be certain to be directed to a reliable specialist, but in order that one may be

Death Rates per 1000 Women, Vassar, Wellesley and Smith Alumnæ. Metropolitan Life Insurance Company—Ordinary Department Experience—1914–1916. New York City Teachers, 1907–1914, and Registration Area, 1910–15

Age period	Vassar alumnæ	Wellesley alumnæ	Smith alumnæ	Ordinary ins. experience, M. L. I. Company	New York City teachers	U. S. reg. W. A. area
20 to 24	1.38	1.52	1.25	.....	1.48	4.96
25 to 34	3.25	2.56	2.58	3.02	2.98	6.10
35 to 44	4.55	4.68	3.26	4.83	4.32	8.03
45 to 54	8.54	5.41	3.54	9.16	9.84	12.58
55 to 64	11.81	10.19	.....	20.04	16.67	24.48

* Table by Myra Hulst, American Statistical Association Quarterly, March, 1921. Used by permission of the publishers.

Fig. 10.

directed to a specialist in the right field. One may, for example, believe that the digestion is at fault when the difficulty is really in the eyes. The best general practitioners do not usually care to treat patients whose ailments are definitely in need of the attention of specialists.

There are specialists in every branch of medicine. They are individuals who have had a foundation in general medicine and have thereafter studied some one aspect of the body in detail. Because their work has been so thorough, general practitioners and laymen should call upon them in circum-

stances when only highly specialized knowledge and skill will suffice.

Quacks who advertise themselves as "specialists" in various disorders (e.g. Cancer Specialists) often mislead the public into thinking them recognized members of the medical profession. It should be understood that regular physicians never advertise, nor do anything to entice patients to come to them.

The study of hygiene should help one to distinguish between genuine knowledge and the countless superstitions and "old wives' tales" current even among those well educated in other respects than in hygiene. Some of these superstitions have a little foundation in fact; others none. Horseshoes in the pocket do not prevent rheumatism, nor amber beads on the neck prevent goitre. Although the intelligent recognize such procedures as absurd, they often have notions that, if not so grotesque, are quite as false—as, for example, that one cannot catch cold while one has a fever, or that staying in bed while ill is "weakening." It is temporarily weakening for the muscles, but may be absolutely necessary for the strengthening of the vital organs. There are other popular misconceptions, too numerous to mention, which it is hoped the succeeding chapters may serve to correct.

Finally, a study of hygiene should lead to a clearer concept of the legitimate use of drugs and medicines, and of the unwarranted use of them. It should lead individuals to respect what may be done by drugs, but to guard against the harm of indiscriminate use of them.

PART II.

ANATOMY AND PHYSIOLOGY

CHAPTER VII

THE GENERAL PLAN OF THE BODY

Anatomy is the study of the structure of the body; physiology, of its functions; and hygiene, of its care, both in respect to structure and functioning.

Some few points regarding anatomy and physiology may be gotten by observation of the body, and some few suggestions regarding its hygiene. Other principles of hygiene may be learned by experience. But in order to have the most sound foundation for hygiene, it is better not to rely entirely on observations and experience, but to get at least a minimum of exact knowledge about the body. The following chapters offer what is believed to be the irreducible minimum. What is given here should be supplemented by a study of the skeleton and of a mannikin, since dissections of the human body are usually not available for students of hygiene.

Without reference to a skeleton or mannikin, any casual observer may reach certain conclusions about the body. It is obvious, for example, that it consists of a hard inner structure of bones; that its outermost layer is of skin; that at the apertures of the body, wherever the skin stops, a pinkish structure somewhat resembling the skin lines the body as far as can be seen; and that between the coverings of the body and the bones there lies a varying amount of soft tissue that one has learned to recognize as muscle and fat.

Certain observations regarding the covering membranes of the body are easily made. It is found, for example, that there is bleeding from the skin when it is cut or broken in any way. Large blood vessels may be observed in certain parts of the body, for example, on the back of the hand. But it is understood that it is not necessary to open one of these in order to produce bleeding. The conclusion would naturally be reached that there is blood everywhere in the skin. This is true except of the extreme outer layer. It might be thought that the blood was lying free in the tissues. This is not the case. It is con-

tained in vessels, and does not ordinarily escape except on injury of its containers. These vessels are many of them so

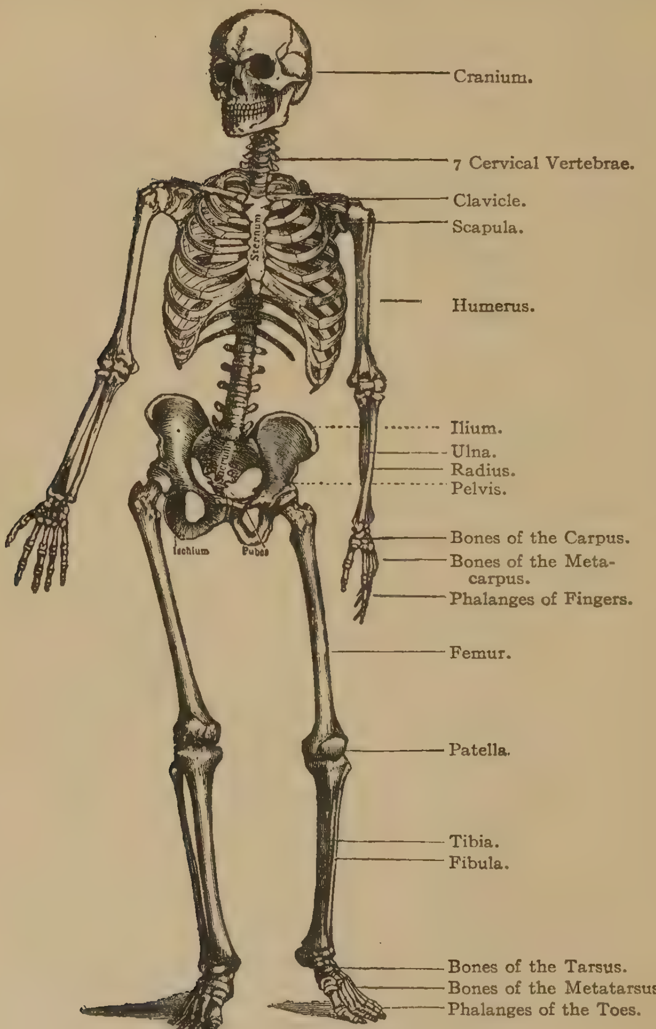


Fig. 11.—The skeleton. (After Holden.)

minute as to be invisible. Since there is a tendency for blood to appear wherever body tissues are injured, it would be

natural to conclude that there is blood everywhere in the body. This is practically the case.

If the skin is touched, sensations appear. If a muscle is pinched, still more sensations appear. If a sound is made, the sense of hearing is aroused. It is to be justifiably concluded that all parts of the body are capable of receiving sensations of some sort or another. If it is known that nerves carry sensations, it would be concluded that nerves are everywhere in the body. Large nerves may be felt—for example, at the "crazy bone" of the elbow; but it is not only when these large nerves are touched that sensation is produced. It is justifiable to conclude that many of the nerves are as minute as many of the blood vessels, and that they are as widely distributed as the minute blood vessels.

Observation of the body also reveals that there are, almost all over the skeleton, structures one early learns to call muscles. The characteristic feature about them is that they are capable of becoming shorter and thicker, and of changing the relation of bones to each other, the bending taking place at joints between bones. Contracting the biceps muscle brings the forearm nearer to the upper arm, for example. The conclusion would be reached that muscles are attached to bones on either side of a joint. It is recognized that, by giving attention to it, all of these muscles may be voluntarily contracted. But it is also observable that they may be contracted under certain circumstances against one's will. A tap on the knee causes the muscles of the thigh to contract in such a way as to move the leg forward with a jerk. It would thus be concluded that not only are muscles capable of contracting at the behest of the will but that they may also contract upon the receipt of certain sensations. The principle of both voluntary and of reflex motion might thus be suspected. The motion that quickly follows a sensation, involuntarily, may be observed to take place in many parts of the body; for example, the quick involuntary winking of the eye when danger approaches.

Another phenomenon that is readily observable is that of the production of fluids by the body. Fluids may be readily observed to exude from various parts of the body—from the

skin, the lining membrane of the mouth, and the tissues about the eye, for example. It will be recognized that some of these fluids are being constantly given off, and that on occasion they increase in amount. It would be concluded that the fluids were produced by the tissues in some mysterious way. It might not be realized, however, how important a part of the physiology of the body this process of secretion is. Both muscle action and secretion go on not only in the observable parts of the body but also in its interior, and together constitute the main forms of functional activity of the body.

It is also observable that the body takes in substances from the outside and gives off again other substances. The body takes in air and food and drink. What it gives off is different from what it takes in. One would naturally conclude that chemical changes had taken place in the body, which is the case. The study of the body involves to a large extent the study of its chemical changes, about which one can learn nothing by simple observation. All that can be learned by observation is that the body apparently needs the substances it takes in because breathing in of air goes on constantly, and the taking of food and drink periodically; and that the body apparently has waste material to be gotten rid of.

Many other observations regarding the body may be made, but their significance is little unless interpreted in the light of a knowledge of that which is not obvious. It is therefore desirable to use the illustrations, the skeleton and the mannikin, to discover how the body is constructed grossly; then to learn something of the microscopic structure and of the chemistry of the body; and then to study the various functions of the body in detail.

The combined study of the skeleton and the mannikin shows that the bones and the soft parts of the body enclose several cavities and that these cavities contain organs. There are two main cavities, the dorsal and the ventral. The dorsal cavity is enclosed entirely by the bones of the skull and of the spinal column, and contains the brain and the spinal cord which is a prolongation from the brain. The ventral cavity extends through the trunk and is enclosed by bones and soft tissues. The upper part of it is called the thorax, con-

tained entirely within the case made by the ribs, the spinal column and the breast bone. The middle part is called the abdominal cavity. It is enclosed by the spinal column and the lower ribs at the back and by soft tissues at the sides and front. Below it is the pelvic cavity, which is enclosed by the

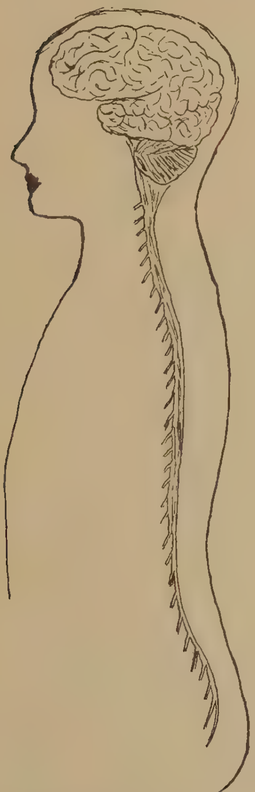


FIG. 12.—The brain and the spinal cord.

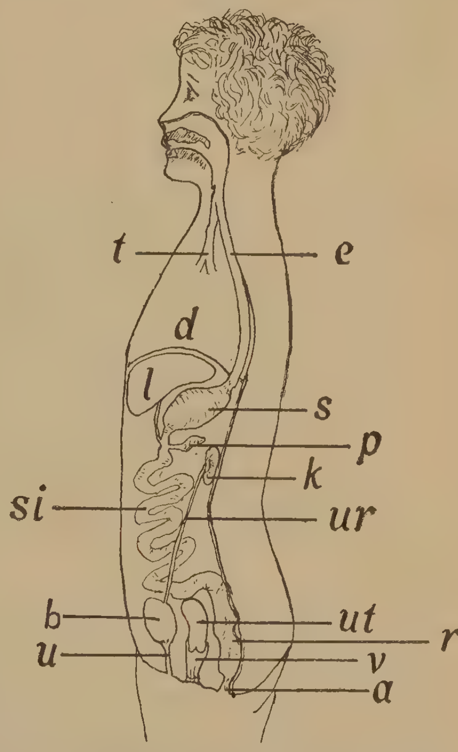


FIG. 13.—Vertical section of the head and trunk. *e.*, esophagus; *t.*, trachea; *l.*, liver; *s.*, stomach; *p.*, pancreas, *k.*, kidney; *ur.*, ureter; *s.i.*, small intestine; *ut.*, uterus; *b.* bladder; *u.*, urethra; *v.*, vagina; *r.*, rectum; *a.*, anus.

lower bones of the spinal column and the hip bones. The thoracic cavity is separated from the abdominal cavity by a sheet of muscle called the diaphragm.

In the thoracic cavity are the heart and lungs. Leading into and out of the heart are large blood vessels. One, the aorta, arches upward and then proceeds downward

through the chest and through the diaphragm into the abdominal cavity. Two others, the pulmonary arteries, go directly to the lungs—one artery to each lung. The aorta gives off branches, some of which go up through the neck to supply the head and arms with blood, and others that go to all of the interior parts of the body and into the legs. Parallel with these big blood vessels that carry blood outward from the heart, the arteries, are others that bring blood in, the veins.

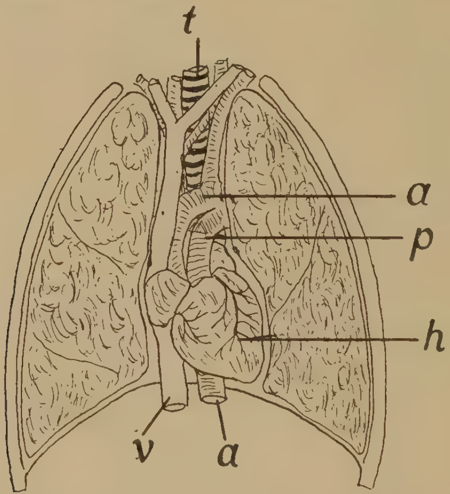


FIG. 14.—Vertical section of the thorax. *a.*, aorta; *p.*, pulmonary artery; *h.*, heart; *v.*, vena cava.

Connected with the lungs are tubes, called bronchi, that bring air into them. These tubes connect with the main air tube, the trachea, that extends upward into the throat and receives air that comes in through either the nose or mouth. The chest also contains another tube, the oesophagus, that passes from the throat directly through the chest to reach the stomach that lies just below the diaphragm. Through the neck from the chest there proceed, therefore, the trachea, the oesophagus and blood vessels, together with the ever-present nerves. Through the diaphragm from the chest there proceed the oesophagus, the aorta and nerves.

In the abdominal cavity are found the stomach, and, connected with it at its lower end, the intestines. The stomach

is a hollow sac and the intestines are a hollow coiled tube many feet long. The plural is used because there are two tubes, which are, however, continuous with each other. Oesophagus, stomach and intestines together are called the alimentary canal. The canal is continuous through the body from the mouth to the anus, its lower opening.

In the abdominal cavity is also the liver, close up under the diaphragm on the right side—an organ concerned in digestion and in preparing material for excretion, and one of the storage

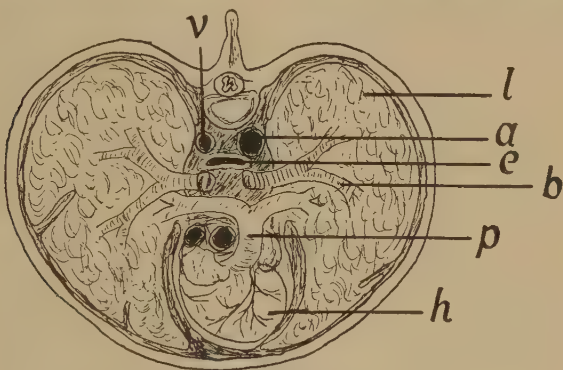


Fig. 15.—Cross section of the thorax. *l.*, lung; *a.*, aorta; *e.*, esophagus; *v.*, vena cava; *b.*, bronchi; *p.*, pulmonary artery; *h.*, heart.

places for body fuel. Underneath the liver and lying close against it, is the gall bladder, which holds part of the fluid product of the liver (the bile), until it is time for it to be discharged into the intestine. Across the upper part of the abdominal cavity, behind the lower part of the stomach, is the pancreas, which provides a substance used in digestion and another substance given off to the blood, which influences body chemistry. The liver, the gall bladder and the pancreas communicate with the intestine by ducts. At the left side of the upper abdomen is the spleen, an organ concerned in maintaining some of the characteristics of the blood. At the back of the abdomen, near the floating ribs, on each side are the kidneys, the organs that have to do with the removal of most of the fluid waste from the body. A duct, called the ureter, leads downward from each kidney to the bladder which is in the pelvic cavity. Filling up all the spare space in the abdomen are the coiled intestines.

The non-rigid walls of the abdominal cavity are for the purpose of permitting the body to bend, and also to change in

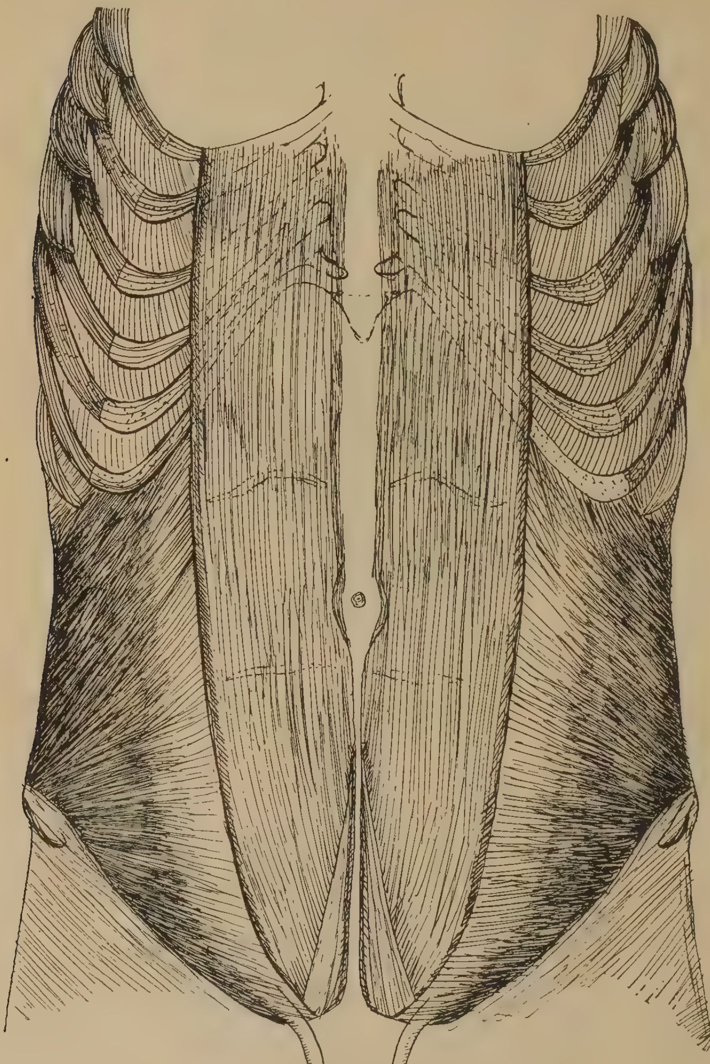


Fig. 16.—The abdominal muscles.

shape and size at need. All of the abdominal organs are fastened to the back wall of the abdomen in such a way that

they are not held rigidly in place, with the exception of the kidneys that are firmly attached. The large muscles in the abdominal wall are for the purpose of holding the wall relatively tense and keeping the organs in their normal position. Throughout the abdomen are found the blood vessels that nourish the tissues and organs, and the nerves that carry sensation from them and bring in impulses for motion and secretion.

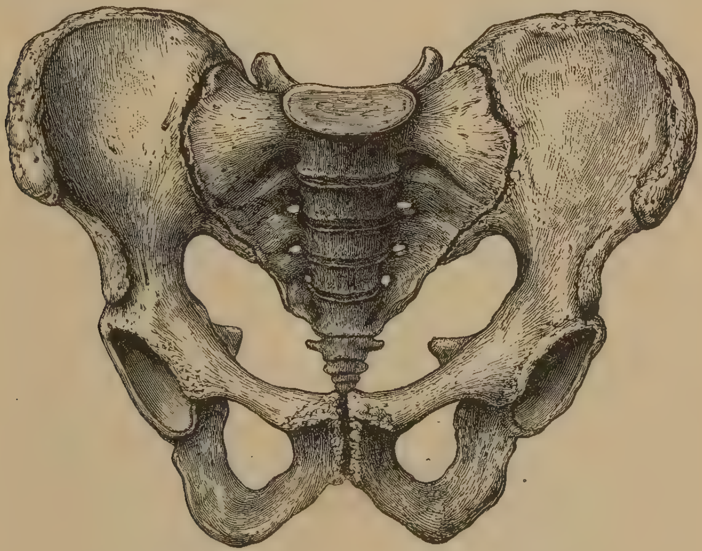


FIG. 17.—The pelvic bones and the sacrum. (Morris.)

The pelvic cavity is fully surrounded by bones except below, where it is closed in by muscles that extend across the opening to hold the organs in position. These muscles are arranged in such a way that there are openings through them from the bladder, from the intestine, and, in the female, from the uterus. The bladder is a hollow sac in the pelvis, which contains urine brought there through the ureters from the kidney. The urine leaves the bladder by means of the urethra which takes it to the surface. The lower part of the large intestine, called the rectum, is also in the pelvis. It leads to the exterior by an opening called the anus.

In the female is found also in the pelvis the uterus, a hollow organ composed chiefly of muscle, in which, after conception,

the embryo develops, until it is time for it to be born. It is in the uterus that the congestion of blood takes place that is periodically given off at the menstrual period. The passage through which the blood is given off, and by which the child is delivered at birth, is called the vagina. It is also by this passage that the male reproductive cells reach those of the female. In the female pelvis there are also two ovaries and tubes leading from near them to the uterus. The ovaries produce the germ cells. In the male there are several glands in the pelvis, but nothing resembling the uterus. The glands corresponding to the ovaries in their function of producing reproductive cells (the testes) are in the male carried in a sac outside the body, known as the scrotum. A passage from them unites with the urethra, which leaves the body through an outward prolongation known as the penis.

The skull, in addition to containing the brain, contains cavities in which are located the eyes and the middle and inner portions of the ear. It also contains the cavities of the nose and mouth. The cavities of the nose (the nares) extend upward and backward into the skull and communicate by ducts with the eye socket, and with hollows in the bone known as sinuses. Posteriorly the nares open into the upper part of the throat or pharynx. There is also a tube from here to the ear on each side. The mouth opens directly into the pharynx. Below the pharynx there are two openings, one into the larynx and the other into the oesophagus, the former leading to the trachea, bronchi and lungs, the latter to the stomach and its continuation, the intestines. The larynx is concerned in voice production.

In various parts of the body are organs known as endocrine glands, which produce chemicals that are given off into the blood vessels and profoundly affect body chemistry. One of these, the thyroid gland, is located at the front of the neck, where it may often be felt.

As has already been mentioned, the blood vessels and nerves are everywhere. The larger vessels are plainly visible, but it must be understood that no region in the body except the hair and nails and one layer of the skin are without them, and even these parts have blood vessels close to them.

None of the structures of the body are homogeneous material, not even bone. Each and every structure of the body and of all living organisms consists of minute parts called cells, which can only be distinguished by the micro-

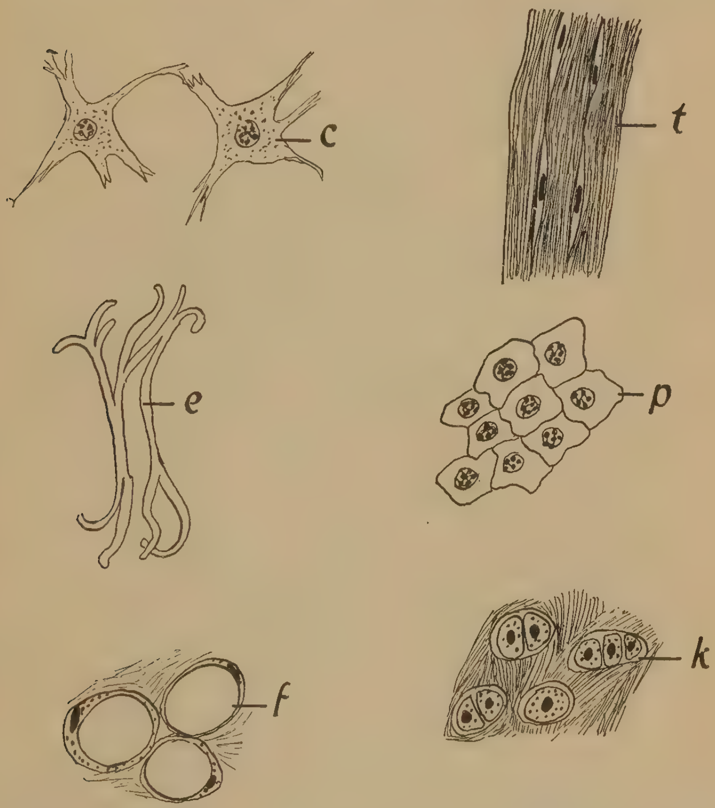


FIG. 18.—Various types of cells. *c.*, connective tissue; *t.*, tendon (connective tissue); *e.*, elastic connective tissue; *p.*, pavement epithelium; *f.*, fat; *k.*, cartilage.

scope; and of intercellular substance which they produce. Cells have been likened to the bricks of which a house is made. In the body there are five main varieties of cells:

a. Epithelial cells, of which the skin and all membranes and glands are composed and with which the blood vessels are lined.

b. Muscle cells, which form three different kinds of muscle.

c. Connective tissue cells, which make up the supporting structures, bone and cartilage, and other supporting tissue that holds together the various more active cells of the body. Wherever other cells are found, connective tissue cells will be found supporting them.

d. Nerve cells, that compose the brain and spinal cord and the prolongations of them, the nerves.

Fig. 19.—Fibro-cartilage.

e. Blood cells, which are found in the fluid of the blood and in the places where they are formed.

Each cell of the body has a life of its own. Because they are alive, the whole body is alive. When we speak of malfunction or disease of an organ, we imply the malfunction or disease of its individual cells. The connective tissue cells are less vitally necessary than some of the others, but in the main the destruction or imperfect function of any considerable number of cells of any kind is hampering to the body. In some organs even a very slight change in the character of the cells results fatally.

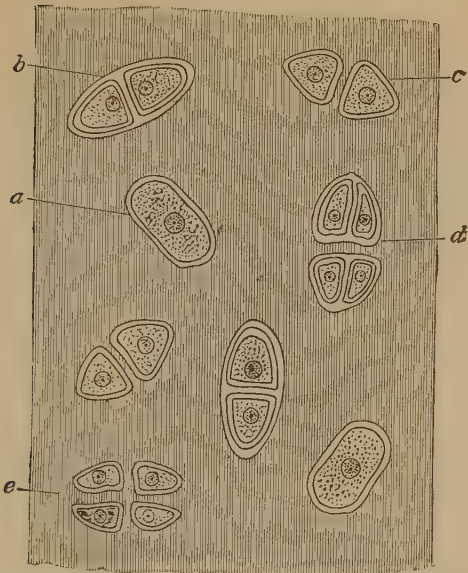


FIG. 20.—Section of cartilage. *a.*, cell in its capsule; *b.*, *c.*, *d.* and *e.*, cells undergoing multiplication. (From Halliburton, "Physiology," 15th Edition.)

FIG. 21.—Fat cells in adipose tissue.

The functions carried on by each cell can best be studied by studying an animal that consists only of a single cell, of which the amoeba is a good example. It takes up from the water in

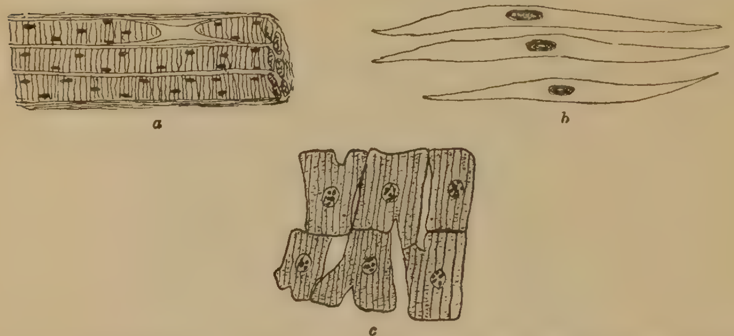


Fig. 22.—Muscle cells. *a.*, voluntary muscle; *b.*, involuntary muscle; *c.*, cardiac muscle.

which it lives all the chemicals that are necessary for its nourishment, changes them over within itself, and gives off the waste that is left over after it has nourished itself and

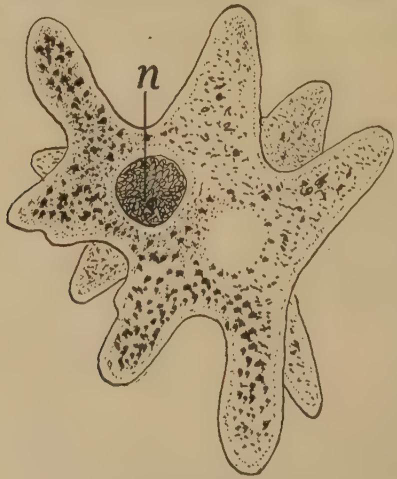


Fig. 23.—The amoeba. *n.*, nucleus.

performed its limited activity. All cells do the same. Each and every cell of the billions in the body takes the chemicals that it needs from the blood, carries on a chemical activity within itself and gives off waste.

Some of the cells have their value in the body because of additional chemical products that they give off besides waste. The epithelial and glandular cells are valuable because of their chemical products. Other cells of the body are valuable because they have peculiar conducting power so that a stimulus felt by the cell is carried all through the cell and passed on to the nearby cells. The nerve cells are of value for this reason. Some of the cells of the body possess the peculiar power of changing their shape in response to stimuli. The muscle cells have their value because they are able to contract, becoming shorter and thicker, by which means the whole muscle that they compose becomes shorter and thicker.

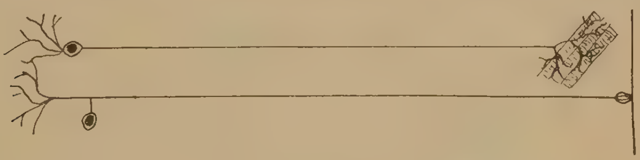


FIG. 24.—Diagram of reflex action. A receptor and an effector neurone in synaptic relationship.

Some of the body cells have their chief value through their ability to take up a great deal of a chemical substance (oxygen) that is necessary for all cells, and their ability to be moved about through the body and to give off a supply of oxygen to the other cells. This is the function of the red blood cells. The white blood cells have their chief value through their ability to devour and render harmless within themselves materials found in the body that would be very damaging otherwise.

The special value of the connective tissue cells is the ability to turn out substances that remain in the vicinity of the cells, called intercellular substance, which is of varying degrees of density and, as has been said, serves the passive purpose of supporting the body.

It will be seen that the cells of the body possess quite different specialized functions. Bone, for example, consists of a few cells and much of the intercellular substance the cells themselves have produced, largely from the minerals in the food. Some of the epithelial cells exhibit the special power of

being able to take poisonous waste material from other cells into their own cell bodies and to make changes in it and finally to turn it off as an excretion into the organs for this purpose.

All cells, whatever their special function, take in oxygen and food for their own nutrition, to repair their own wear and tear and to carry on their activity, and give off waste as the result of their own nutrition and activity. All cells, whatever their function, are irritable to certain stimuli; that is, they carry on their life processes according as they are stimulated to do so. There are many sorts of stimuli that act upon cells, inciting them to activity, of which the chief varieties in the body are the stimuli due to certain chemicals that reach them and set

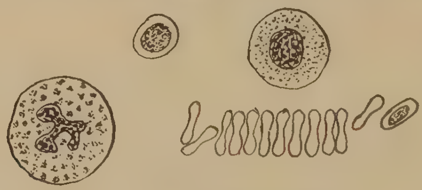


Fig. 25.—Red blood corpuscles.

up chemical reactions; and the nerve impulses that form the basis of nerve reactions. Each living cell is in contact with the blood, through which it receives the materials it needs for its nutrition, the materials from which it makes its products, and the materials that serve as stimuli to its activity. Each living cell is also in communication with the nerves that carry impulses bidding it act or not to act, as the case may be.

The amoeba has the power of reproducing its kind as well as of maintaining its own life. The cells of the body have this power up to the point where the organ they compose has attained its full growth. Thereafter only a few of the cells continue to reproduce. Blood cells are constantly being destroyed and reproduced, as are also the epithelial cells of the skin and mucous membranes. Other cells of the body reproduce mostly for the purpose of repairing damage to the part of the body they compose, in order to make up again the full number of cells.

The individual cells of the body are of varying appearance, but are alike in possessing a definite outline and a definite

structure which characterizes each kind of cell, and alike in having a roundish, well-defined body in each, called a nucleus. The red blood cells are exceptions, in that, when mature, they lack nuclei. It is the nucleus that gives the cell its reproductive power. It is the germinating portion of each cell.

The material of which each cell is composed is called protoplasm, but the protoplasm is not of identical chemical composition in each cell. It varies according to the function the different varieties of cells carry on.

Protoplasm is a complex chemical substance composed of carbon, hydrogen, oxygen, nitrogen and sulphur, and usually many other elements also. A very large proportion

Fig. 26.—Food and oxygen passing into a cell; waste and carbon dioxide passing out. (From Ritchie, "Human Physiology." Copyright 1908, 1915, 1920 by World Book Company, Yonkers-On-Hudson, New York.)

of protoplasm is water. All cells are semi-fluid. In all there are about sixteen elements that enter into combination with carbon, hydrogen, oxygen and nitrogen in forming the various parts of the body, but these four form 97 per cent of the body.

The characteristic thing about the chemistry of the body is its instability. Each cell is in a constant state of chemical activity, a regular whirlpool of change. In its last analysis, life may be said to consist of the changes in the protoplasmic molecule. The sum of all these changes in the body is called its metabolism. The metabolism of bone is not the same as that of such glands as the liver. Each kind of cell uses carbon, hydrogen, oxygen and nitrogen, but in different proportions, and each uses the other elements in different proportions. The

metabolism of bone cells, for example, involves the use of much calcium and phosphorus, in order to make the intercellular substance that characterizes bone. As the other parts of the body are studied, it will be seen that the chemical changes vary with different organs and tissues.

The metabolism of the body as a whole or any part of it, consists of two phases; the upbuilding process and the tearing down process. The positive or constructive phase is known as anabolism; the negative or destructive phase is known as katabolism. During life both keep pace, except that the sum total of anabolism is greater in youth, and that of katabolism is greater in old age. Through the greater part of life the body chemistry is balanced by an amount of anabolism to equal the amount of katabolism—in other words, as fast as the cells use up their chemicals, new ones are supplied, and the cells themselves vary from a normal depletion to a normal repletion. The assimilative or constructive stage in cell life is that which is in preparation for its activity; the dissimilative or destructive stage represents its actual activity. One stage follows the other in sequence, or they occur coincidently, throughout life.

Although all the cells of the body are not performing their work all the time, chemical processes of one sort or another are going on all the time. It is possible by overwork of certain of the cells to cause their katabolism to exceed their anabolism. During sickness the general katabolism usually exceeds anabolism. In undernutrition anabolism is not sufficient to meet body needs, and the cells waste. The chief aim of all hygiene is to keep the body chemistry in a state of equilibrium, in order that each cell may maintain its structure and its functioning ability. It must be stated, however, that the building-up process, or the preparation for activity of cells, is better carried on if there has preceded this a judicious degree of wear and tear on the cells.

The way in which the chemical changes that constitute metabolism take place is most interesting. In the first place, each cell must have access to a supply of the chemicals it needs. This is arranged for by having each cell in contact with the fluid from the blood. Each cell has access to the same kind of

blood fluid; yet each kind of cell takes from the blood different chemicals.

This rather mysterious power of the cells to take what they want and need is now explainable according to the laws of physical chemistry. Before the application of these laws to body processes, there was thought to be some strange "vital" power in the cells that did not operate according to any knowable laws. It is now understood that one of the important reasons for the cells taking what they need is that there is a difference in osmotic pressure within the cell and outside it, and that certain chemicals pass through and others do not, according to the physico-chemical laws that govern the passage of fluids and gases through membranes.

As a result of the passage of substances into cells, by osmosis or otherwise, various chemical changes take place, of which the most general and important is known as oxidation, or the combining of chemicals within the cell with the oxygen it receives from the blood.

The essential nature of the metabolic process has long been considered primarily that of oxidation. Any organic substance that burns takes up oxygen and gives off carbon dioxide and water, with at the same time the production of heat. Since the heat may be easily transformed into mechanical power or energy, heat itself may be considered as a variety of energy, and the two terms may be used almost synonymously. Lavoisier began the experiments that finally resulted in our knowledge that this is exactly what often takes place in the body cells: oxygen is added to the chemicals in cells, they give off as end-products carbon dioxide and water, and they generate heat and potential energy during the process.

In the human body the potential energy becomes actual energy either at once or later. It is exhibited in the contraction of muscles, the secretion of gland cells, the conduction of nerve impulses, and even, probably, in the process of thought. All involve oxidation processes at some stage, for it is by oxidation in cells that each cell gets its power to produce its particular expression of energy. Whatever the direct cause of the contraction of muscle, for example, oxygen is utilized as a result of its activity, and when the oxygen

supply is reduced below a given point, it must be renewed before further mechanical force may be exerted by the muscle.

In order to have oxidation in cells there must be present in them combustible material, obtained from the food through the blood; and there must be present also the agent of combustion, oxygen, obtained from the air through the blood. The combustible materials are so because they lack oxygen and have an affinity for it.

It will be seen that life processes would fail if either combustible material or oxygen were not supplied in sufficient available quantities. Oxygen starvation is the quickest cause of death, food starvation producing death more slowly because the combustible material already in the body may serve to keep the body fires burning for a time. Starvation in respect to water is a quicker cause of death than starvation in respect to food, because all chemical processes, in order to take place, require a fluid medium in each cell.

The life processes also suffer if the end-products of chemical activity are not removed. This is particularly true of an excess of carbon dioxide. Other cell wastes are to a varying degree hampering to cell activity, and thus to the body as a whole.

In addition to oxidation there occur in the body many chemical processes that involve the taking up of water by molecules and the subsequent splitting of the molecules. Still other chemical processes go on, that are synthetic in nature. Many chemical changes in the body depend on differences in hydrogen ion concentration, a discussion of which would require more space than is justifiable to give to it here.

There is a reciprocal relationship between the metabolism of plants and of animals. The harmful animal wastes supply the most important needs of plants; whereas the plant world is a large source of the combustible material which animals use.

Since the constitution of protoplasm is so varied and so changeable, the significance of a suitable and varied diet should be appreciated. The cells cannot work unless their structure is maintained by supplying the chemicals necessary to their composition, and their functioning power made possible by supplying the chemicals they use when they work.

Cells of one kind make up the various fabrics of the body that are known as tissues. Some of the tissues consist mostly of cells, (e.g. epithelial) and some have much intercellular substance (e.g. connective tissue). The tissues are named as the cells are—epithelial, muscle, connective, nerve, and blood. About half the body by weight is muscle tissue; more than a third is connective tissue (including bone, cartilage and fat); less than one-tenth is skin and membranes; one-twentieth is blood; and about one-fiftieth, nerve tissue (brain, cord and nerves).

Epithelial tissue is of several different kinds. The simplest consists of a single layer of flattened cells such as line the blood vessels—called in such a location endothelium. Another sort consists of a single layer of cells that are somewhat columnar in shape. Sometimes epithelial tissue consists of many layers, the lower ones roundish and the upper layers becoming more flattened, until the surface layer is quite flat. This is the sort composing the skin.

Epithelial tissue is largely for protection of surfaces both inside and outside the body, and inside and outside many organs. But it also composes all the secreting surfaces and secreting glands of the body. Glandular epithelium, as it is called, is among the most highly specialized tissues in the body. The epithelial cells are arranged on an underlying network in which blood vessels run. The gland cells take chemical substances from the blood, make them over and give out a product that is different for different kinds of cells. There are many kinds of epithelial cells that produce secretions which they either pour out on to surfaces of the body, or pour into ducts, or turn back into the blood vessels. The various kinds will be referred to in reference to the skin, the mucous and serous membranes and the glands and glandular organs (such as the thyroid, the liver and the kidney, that consist of aggregations of gland epithelium). Aside from being supplied with blood vessels, gland epithelium is also supplied with nerves that regulate the amount of secretion produced.

Connective tissue, or supporting tissue, consists of a few cells and much intercellular substance. The main varieties are osseous (bone), cartilaginous, fibrous and adipose (fat).

Cartilage is found on the ends of bones and in joints. Fibrous and adipose tissue are widely scattered through the body. Fibrous tissue occurs in varying amounts among epithelial, muscle and nerve cells, for the purpose of supporting them. It is the kind of tissue that replaces the higher tissues when they are destroyed and are unable to reproduce themselves. Fat tissue is found in the layers underneath the skin, among the muscle fibres and in several special fat repositories in the abdomen.

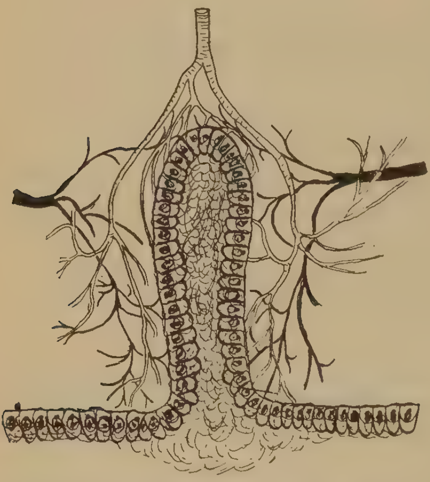


FIG. 27.—A gland with its blood vessels. Note the product of the gland in its lumen.

FIG. 28. — The biceps contracted so as to bend the arm at the elbow.

Muscle tissue is found making up the muscles that are attached to the bones (skeletal muscles) for the purpose of moving the bones in relation to each other. Since these muscle fibres may be contracted at the bidding of the will, they are called voluntary. A few of them, such as those in the abdominal wall, are attached to the soft parts of the body. There are two other kinds of muscle fibres—those that make up the heart muscle, and those that are found in the organs that have motor power. Both of these sorts are involuntary, in that their contraction cannot be controlled by the will. Among the important places where involuntary muscle is

found, besides the heart, are the wall of the stomach and intestines, the wall of the uterus, in the larynx, in the eye, and in the walls of the blood vessels. These muscles perform their contractions according to the body needs without any conscious direction.

Nerve tissue is found in the brain, in the spinal cord, in the nerves given off from each, and in various ganglia near the brain and cord and elsewhere. The nerves extend all through the body, by giving off countless minute fibres. Nerve fibrils are as omnipresent as blood vessels. The nerve cells themselves are all contained in the brain, the cord and the ganglia. They give off processes that unite with processes from other cells to form bundles called nerves. The nerves subdivide, and subdivide, until they cannot be seen except through the microscope, yet each fibril is connected with a cell in the brain or cord. With the exception of the outermost cells of the skin, all the body cells are in communication with the brain and cord. Supporting the nerve cells and along with the nerve fibres there is some connective tissue.

The blood is a fluid tissue, consisting of cells, known as corpuscles, in a fluid intercellular substance.

A tissue is a rather simple structure consisting of an aggregation of like cells and intercellular substance. In the active tissues the whole tissue or fabric acts as do the single cells of which the tissue is composed. An organ is a much more complicated structure consisting of several different kinds of tissues, each performing its own single function in such a way that the organ as a whole accomplishes a coördinated function that is the sum of the action of all its tissues and of each cell of each tissue.

An illustration of coördination of tissues is found in the stomach, an organ for the digestion of food. In order to accomplish its complicated function, the stomach contains muscle fibres that make its walls contract so as to churn the food about, and finally discharge it into the intestine; epithelial tissue containing secreting cells to produce the several different varieties of secretion that mix with the food and make chemical changes in it; connective tissue to give support to muscle and gland cells; nerve fibrils to carry impulses to cause both

motion and secretion to take place; and blood, from which comes the nourishment of all the cells and the materials which enable the muscle cells to contract and the epithelial cells to secrete. An organ is, then, a collection of various kinds of tissues, grouped in an orderly way so that a special function may be performed that no single tissue alone could perform.

Even an entirely satisfactory stomach would not, however, be able to complete the elaborate process of the nutrition of the human body. The stomach does only a part of the work. Other organs are necessary to do what precedes stomach digestion, and what follows it. There is, therefore, an aggregation of organs for the common purpose of dealing with the food, called the alimentary apparatus or system. In the body there are several such main groups of structures or organs. They are the *locomotor* system, which comprises the skeleton and skeletal muscles; the *tegumentary* system, comprising the covering and lining tissues of the body; the *circulatory* system, consisting of the heart, the blood vessels and the lymph vessels; the *respiratory* system, consisting of the lungs and the tubes that lead into them; the *alimentary* system, consisting of the mouth, the oesophagus, the stomach, the intestines and the glands that turn digestive secretions into them; the *excretory* system, consisting chiefly of the kidneys, the ureters, the bladder and the urethra; the *nervous* system, consisting of the brain, the spinal cord, the nerve ganglia and the nerves; the *reproductive* system, consisting chiefly of the glands that produce the germ cells, the ducts through which they travel and, in the female, the uterus; the *endocrine* system, which consists of several glandular structures variously located in the body, that produce secretions that are poured into the blood.

Some of the organs of the body take part in the functioning of more than one system. The total excretion from the body, for example, is not performed exclusively by the excretory system. The function of temperature regulation is provided for by no special organs, but is performed by organs that belong to several of the main systems.

No organ can be deranged without deranging to greater or less degree the system to which it belongs; and no system can be deranged without affecting more or less all the other systems.

The unified, harmonious action of all parts of the body is the most remarkable phenomenon. That any one cell can act as it does is remarkable, but that millions of them should be able to act simultaneously in such a way that one need not be aware even of their functioning would be beyond comprehension if one knew nothing of the coördinating action of two of the systems of the body.

The various parts of the body are in constant communication with each other in two ways. First, by means of the nerves impressions from every part of the body reach the centers where the nerve cells are. From there impulses are sent out to every part of the body, stimulating each part to activity. Some of the incoming messages reach the brain, and one is aware of them. Conscious action may follow. But many, in fact most, of the messages from the organs do not get so far as the brain; one is not aware of them, and the activity that results is not conscious. A special part of the nervous system (the autonomic) has most to do with this unconscious regulating of organ activity, which is, for the purpose, far more effective than any conscious direction of body processes could possibly be.

The other means of coördinating the activity of the various parts of the body is by means of chemical substances that circulate in the blood. Chemicals that are produced in one part of the body, circulate in the blood and affect other organs are called hormones. Chief among the producers of hormones are the endocrine glands. If they are not produced in the proper amounts the functional harmony of the body is upset in many possible ways. Substances that act as hormones are also produced in many other parts of the body, however.

Both the nervous system and the endocrine system, the important regulating systems, are dependent for their own well-being on the health of the other systems. In view of the complicated interrelation of organs and of the products of cells, it should be clear that every care should be taken to keep all the organs and all the tissues in health, and to provide every facility for speedy restoration to health if any deviation from the normal takes place.

B.

CHAPTER VIII

THE SKELETAL AND MUSCULAR SYSTEMS

The skeleton consists of 206 bones, of which the names and locations should be noted although not necessarily memorized by the student of hygiene. The arrangement of the bones may be best studied by the examination of a skeleton.

It will be noted that the spinal column extends from the head to the hips and is the main longitudinal support of the body. Animals, including birds and fishes, that are characterized by the possession of a spinal column are called vertebrates. The importance of the spine is vastly greater in man than in most animals, in that man habitually attempts to carry the body in a vertical position, throwing all the weight of the head and the trunk on to the spine for support, and at the same time demanding a good deal of motion for these parts. This intricate balancing procedure may be accomplished if the spine is lined up as it is intended to be, providing the muscles are strong enough to keep the bones in proper relation.

The spinal column will be seen to consist of twenty-four vertebrae, continued below by two other bones, the sacrum, consisting of five fused vertebrae, and the coccyx of four. The sacrum lies between the two bones that form the hip girdle.

At the upper end is the skull, consisting of twenty-two bones welded together. Some of these bones enclose the cavity for the brain and the others make up the bony foundation of the face. An opening will be observed at the base of the skull through which the spinal cord passes out.

Each vertebra is shaped somewhat like a disc with projections from each side that unite to form a ring through which the spinal cord passes, and with various projections to which ribs, muscles and ligaments are attached. In one's own back can be felt the processes that extend backward from the vertebrae whose bodies are very deeply situated. The upper vertebra (atlas) has projections on which the skull rests.

The second vertebra (axis) has an upward projection which fits into a hole in the atlas, giving pivotal motion to the head. The next five vertebrae (the cervical) make up the bones in the neck. The next twelve vertebrae (the thoracic or dorsal) are characterized by serving as the attachment for the ribs. One pair of ribs is connected with each vertebra. The upper seven ribs arch downward and forward and then upward where they are finally attached to the breast bone (sternum) in front. The next three follow the same direction but are attached in front by cartilage to the seventh rib. The lower two slant downward and are not attached at their outer ends, hence are called the floating ribs. Particular attention should be given to the direction of the ribs, the angle they form with both spine and sternum, and the angle they form with each other in front. The next five vertebrae (the lumbar) are very heavy and substantial because they form the sole support of the body at the waist.

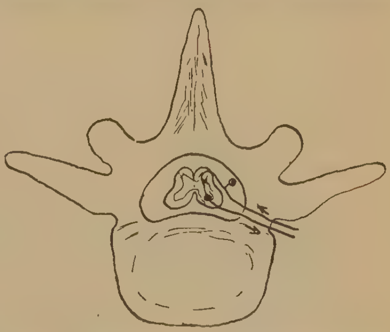


FIG. 29.—Cross section of vertebra and spinal cord, showing spinal nerves.

The spine is in the exact middle of the body and should be straight when viewed from the back. A side view of the spine shows that it normally has three slight curves, one with the convexity backward in the dorsal region, and one with the convexity forward at both the cervical and lumbar regions. These three curves should be very slight and are for the purpose of giving the spine resiliency and at the same time enabling it to keep its main axis perpendicular.

In examining the vertebrae the rings should be noted that carry the spinal cord, and the openings at the sides of the vertebrae through which the spinal nerves pass out. As has been mentioned, the cavity of the skull and that through the vertebrae is called the dorsal cavity of the body.

The thorax, it will be noted, has attached to it two small bones, the clavicle (collar bone) and scapula (shoulder blade).

The former is attached to the sternum, as the ribs are, at its inner end. At the outer end it makes a joint with the upper end of the arm. The scapula lies on the back of the chest, and is attached only by muscles. At its outer end it, too, makes a joint with the upper end of the arm. The arm is thus attached to the thorax only indirectly by means of these two bones, only one of which makes a joint with any bone of the thorax. This allows for great mobility of the arm. The clavicle is largely for the purpose of buttressing the arm so that the shoulder will not fall forward.

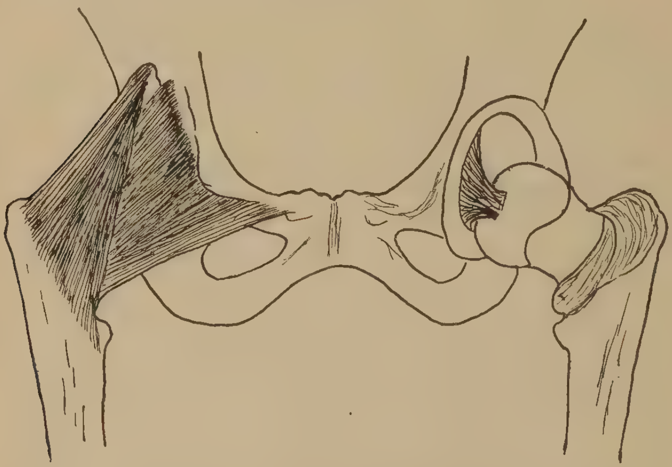


Fig. 30.—The hip joint, showing end of femur (thigh bone) and ligaments.

The leg, however, is much more firmly attached to the hip bone. It will be seen that there is an inward projection with a rounded end that fits into a depression of the hip bone, to which it is held by firm ligaments and by muscles passing over the joint. It will be noted that the extremities are alike in having one bone in the upper part, two bones in the lower part, and a similar collection of bones on the end of each, comprising the wrist and hand, ankle and foot. The arrangement of these, especially of the ankle and foot because of its weight-bearing function, should be examined closely.

The other bones in the body are the patella or kneecap, which is situated in a muscle tendon on the front of the knee;

the hyoid bone in the front of the neck; and the three minute bones in the middle ear, which cannot be seen by examining the skeleton.

The bones, it will be seen, are of many sizes and shapes. Their structure varies somewhat according to their natural function. All of the bones have on the outside a layer of hard compact bone and an inner portion that is softer and somewhat spongy. Where great strength is needed, there is more of the compact bone. The long bones are those that are cylindrical in shape, having a shaft which is hollow, and two slightly larger ends.

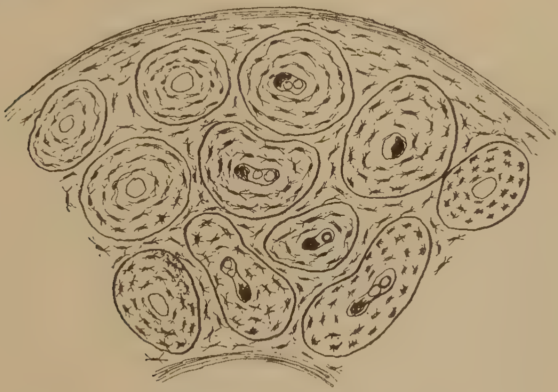


Fig. 31.—Cross section through bone.

In the spongy part of bone and in the shafts of the long bones is found a substance called marrow, which consists chiefly of fat and blood. In the shafts of the long bones the marrow is yellow because of the predominance of fat. In the spongy bone the marrow is red because of the predominance of blood. It is in the red marrow that the constant new supply of red blood cells is formed. Throughout even the compact portion of bones there are openings through which blood vessels run, for the purpose of supplying the bone with its nutrition. These blood vessels come from larger ones that are carried in the epithelial covering adhering closely to the bone. All bones have such a covering, called the periosteum. The shafts of the long bones have also a similar lining, the endosteum.

Inspection of bones shows that they possess what are called articular surfaces, where one bone comes in contact with another, usually for the purpose of allowing motion. The long bones have such surfaces at each end and the irregularly shaped bones have them perhaps in several places where they touch several other bones, as may be observed in the bones of the wrist and ankle. On many bones will also be found roughened areas for the direct attachment of muscles to the bone, the same muscle being attached, usually by a tendon, at its other end to another bone on the far side of an intervening joint.

Fig. 32.—Origin and insertion of one of the flexor muscles of the arm.

The function of bone may be said to be to support the body and give it form; to protect and shelter organs that lie within the bony cavities; and to act as levers for the muscles, permitting motion, locomotion and balance.

Some bones are fitted so closely to others that no motion is possible, as for example, the bones of the skull and face, of which the only movable one is the lower jaw. Some bones fit so closely to others that only a small amount of motion is possible, as for example, the ribs and the sternum. Other bones are so arranged in relation to each other that a great deal of motion occurs in some directions and very little in others. Among the most freely movable joints are those between the lower jaw and the skull, and between the arm and the scapula and clavicle.

In order to make motion possible, muscles must be attached to each of two bones having a joint between them. Then

when the muscle contracts (shortens), the two bones are brought toward each other, lessening the angle between them. The ends of the long bones are especially constructed to permit of easy comfortable motion. They are covered with cartilage, which, although very firm and resistant, is not so hard as bone. It lessens the impact between bones in the motions of walking, for example. Discs of cartilage are also placed between the vertebrae for the same purpose. There are also cartilages between the ribs and the sternum, so that the chest has a certain amount of "give" and its bones are therefore less likely to fracture. In the larger joints such as the knee there are also separate cartilages that act as cushions to soften the shock of bone striking on bone in walking.

Connecting the bones that enter into joint formation are also ligaments. These are of very tough fibrous tissue, and are in

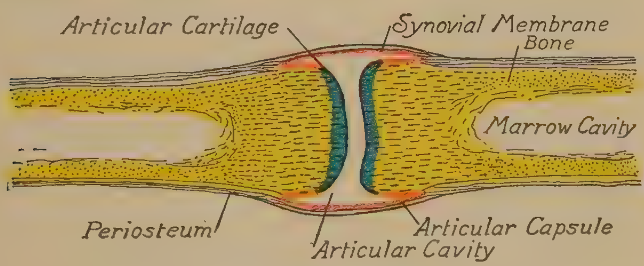


FIG. 33.—Diagram of a hinge joint. (From "Morris' Human Anatomy.")

the form of bands or in the form of a capsule entirely surrounding the joint. Joints are held together both by the ligaments and by the muscles or tendons of muscles that pass over them. It is noteworthy that without firm muscles the ligaments are not strong enough to keep joints tight. An individual with flabby muscles usually has rather loose joints. All joints are lined with a variety of glandular epithelium called synovial membrane, that produces a very small amount of fluid for lubricating the joint surfaces.

The motion obtainable depends on the shape of the articular surfaces. At the elbow and knee and at many other points, hinge motion is produced. At the hip and shoulder and thumb, there is found the ball and socket joint that permits motion in

any direction. Many joints move only a little in a gliding motion, such as occurs between the vertebrae and among the small bones of the wrist. Even in such cases, the sum of a small amount of motion between the bones may result in a considerable aggregate of motion.

Fig. 34.—The muscles that support the spinal column and the abdomen. (From Ritchie, "Human Physiology." Copyright 1908, 1915, 1920 by World Book Company, Yonkers-On-Hudson, New York.)

The arrangement in the spine is particularly advantageous, since the large number of joints makes for great flexibility, so that the spine may move in many directions.

One of the great advantages of the jointed structure of the body is that it saves the wear and tear that would result from rigid construction. The devices that give "springiness" to the body are: first, the ability to bend a bit at a number of places to adapt to jarring motion; second, the normal curves of the spine that distribute shocks as a perfectly straight spine would not; third, the arch of the foot, that by its flexible construction gives the gait greater resilience; fourth, the already mentioned cartilages in the joints. It is only by keeping the curves normal, and the bones in such relation to each other as to make full use of the cartilages, and the muscles in condition to respond quickly to the necessity for slight bending, that full advantage may be taken of the body construction. If there is any question about the desirability of doing so, one need only experiment in jumping with the feet, ankles, knees, spine and neck held rigidly.

The muscles, of which there are several hundred, vary in size from less than one inch to more than twenty-four inches

long. In shape they are classed as either long or short, circular, tubular or sheet muscles. Microscopically, they consist of thousands of long narrow muscle cells mixed with fat tissue and with some fibrous tissue. The aggregation of cells is usually enclosed in a fibrous sheath. The fibrous tissue among the muscle cells, together with the sheath, is prolonged beyond the muscle fibres and constitutes the tendon of the muscle. Such tendons may be felt in the wrist and hand. Usually a muscle at one end is attached directly to a bone, and at the other end its tendon is attached to another bone. The flat muscles, such as those of the abdominal wall, have wide flat tendons that are attached to the soft tissues.

Fig. 35.

Fig. 36.

Fig. 35.—Diagram to show how a muscle in the arm bends a finger by means of a tendon. (From Ritchie, "Human Physiology." Copyright 1908, 1915, 1920 by World Book Company, Yonkers-On-Hudson, New York.)

Fig. 36.—The triceps muscle extending the arm. The biceps, a flexor muscle opposing the triceps, is relaxed.

There are three main kinds of muscle: skeletal or striped or voluntary muscle, intended to move the bones at will; smooth, visceral or involuntary muscle, found in the organs and acting without volition; and cardiac muscle, which is also involuntary

but somewhat different in appearance from the other visceral muscles.

The primary characteristic of all kinds of muscle is that it can contract. It is able to do this because each cell can contract—that being the specialized function of the muscle cell. But muscles also have the power of extending or being stretched passively. When one set of muscles contracts, its opposing set is being stretched. The muscles are also somewhat elastic—that is, when they are stretched, they tend to resume their original shape again of their own accord.

In health the muscles are in a constant state of slight contraction or of incomplete relaxation. This is called muscle

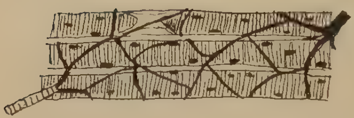


Fig. 37.—Muscle fibres and their blood vessels.

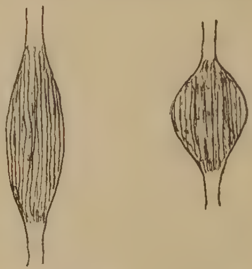


Fig. 38.—Muscle relaxed and contracted.

tone. It is believed to be due to constant slight nerve stimuli. The advantage of it is that when the muscle begins to move, it has less inertia to overcome. Although this is important in the skeletal muscles, it is particularly so in the cardiac and visceral ones, whose smooth full action is essential to life. Great difficulty in function of many kinds results from muscles that sink back to complete relaxation between each contraction. Generally muscle tone throughout the body is very nearly alike. If the skeletal muscles are flabby and lacking tone, the cardiac and visceral muscles are likely to be in the same state.

The power all the muscles have of contracting is dependent on their ability to store up and later to oxidize a substance called glycogen, obtained largely from the carbohydrate in the diet. All muscles have an abundant blood supply, and they

take as much glycogen as they need. They also take up oxygen. When the fuel substance and the oxygen unite, the chemical changes produce heat and prepare the muscle fibres to contract—that is, to become shorter and thicker. The muscles have been called the fireplaces of the body since they are the largest source of heat production. They might also be likened to engines, since they generate motor power. Various other chemical changes, in addition to oxidation, take place in muscles in order to make their contraction possible.

Although the chemical changes enable motion to occur, actual motion does not take place unless the nerve to the muscle brings impulses to move. As has been mentioned, the skeletal muscles move readily at the direction of the brain. The voluntary muscles also at times act in an involuntary way. In response to a sudden sensation a motion may follow quickly, perhaps without the individual even perceiving it. This is called reflex motion. All visceral or involuntary muscle activity is on this principle, certain sensations the organ receives being quickly turned into action.

Like all body cells, the muscle cells contain waste products after working, that must be removed. The muscle waste products are carbon dioxide and sarcolactic acid (in the form of lactates), which are given off into the blood. It is due to the accumulating of the products of muscle activity that the sensation known as fatigue is observed after hard work. The sensation is felt both in the muscles that have become fatigued and in other parts of the body to which the fatigue acids are carried. It is thought that a very large part of the lactic acid is made again into glycogen, to serve again as the means of further contraction.

A summary of the functions of the muscles would include: first, protection (where they enclose such cavities as the abdominal); second, the production of body heat; third, the support of the skeleton, by holding the bones in their correct relation to each other and keeping the joints firm; fourth, making possible motion of the skeleton, and its locomotion, and motion of certain of the organs. Under the fourth consideration the ability of the organism to perform work is of course included.

The muscles form nearly half the body weight. Much of the food that is taken is utilised by the muscles. A great part of the activity of the nervous system is engaged in directing the muscles. All in all, the muscles are a very important part of the body, and the health of the body is somewhat in proportion to the health of the muscles.

The health of muscles is not always in proportion to their size. The size of the muscles varies somewhat according to type of stature, and also according to their training. They increase in size until twenty to twenty-five years of age, at which time they probably reach their maximum vigor. The strength of muscles is measured in foot pounds of work (i.e. the number of pounds they will lift a given number of feet). Strength, skill and precision in the use of muscles depends partly on their size and partly on "knack," which is a matter of training in coördination with the nervous system. When muscles are not used at a given task, they perform it awkwardly because of this lack of habit in acting together upon the proper nerve stimuli.

Although muscles in contracting utilise glycogen, largely from the carbohydrate in the diet, they are themselves nourished largely by the protein in the diet, which enables them to grow during the growing period and to maintain their structure after growth is attained. But muscles deteriorate rapidly even on a good diet, if they are not used. After a few days without exercise, for example, the muscles have lost already a little of their power, although this is quickly regained when exercise is resumed. If a part of the body must be kept motionless for some time (as in splints or bandages), special efforts have to be made to keep the muscles in condition. If the deterioration of muscles is extreme, there may be found only a few muscle fibres left in the muscle, the rest having been replaced by connective tissue. Those who habitually do no voluntary exercise are likely to have muscles throughout the body, even in the heart, that show little resemblance to healthy muscle.

It is not necessary to learn the names of many of the muscles but only of a few of those that are functionally most important. Commonly when muscles are spoken of one thinks of the

skeletal muscles—such as those in the arms and legs; but the most vitally important muscles are elsewhere. Chief among these is the diaphragm, the sheet muscle that stretches across the base of the thoracic cavity, separating it from the abdominal cavity. It should be noted that it is dome-shaped, arching up rather high into the thoracic cavity. In the center it forms a tendon that is attached to the deep-lying connective tissue

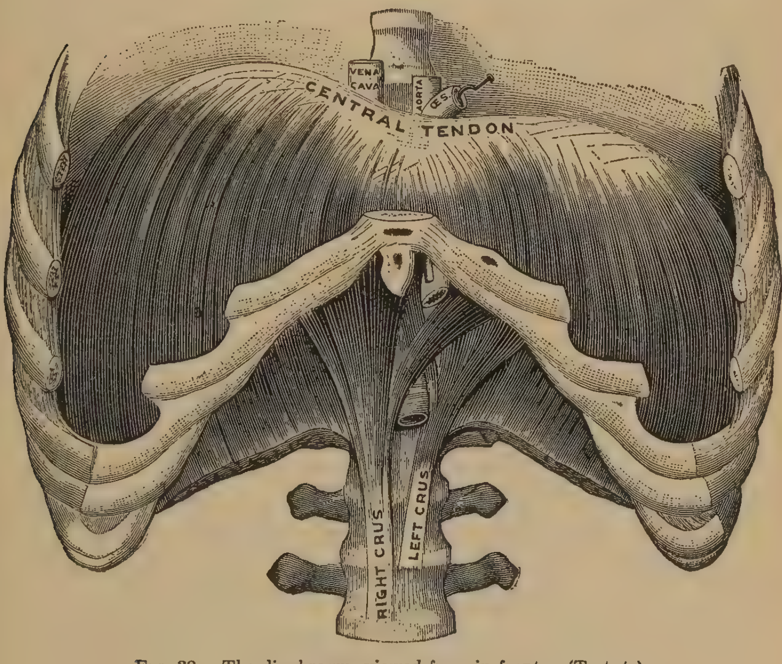


FIG. 39.—The diaphragm, viewed from in front. (Testut.)

in the neck, as well as to the membrane that surrounds the heart. When one breathes in, the diaphragm becomes somewhat flatter, whereas in breathing out it rises higher into the thorax. It is a voluntary muscle, although the act of breathing usually goes on quite unconsciously. The function of the diaphragm is chiefly that of promoting breathing, although it has important uses also in aiding circulation.

Other very important muscles are those that increase the diameters of the thorax; those that hold the head and spine

erect; those in the leg that keep the arches of the feet high; those that permit swallowing; those that control voice production; those that move the eye and change the size of its pupil. Especially important are the heart muscle and the visceral muscles. All of those mentioned and many others are referred to elsewhere in the discussion of the organ or system to which they belong.

CHAPTER IX

THE NERVOUS SYSTEM

The nervous system is for the purpose of coördinating the parts of the body with each other, and the body as a whole with its environment. Its axis consists of the brain, located in the skull, and the spinal cord, which extends downward from the brain through the dorsal cavity of the body in the spinal column. The brain consists of the cerebrum and the cerebellum and a number of smaller structures, that need not be named here.

Within the brain and cord are nerve cells which have two sorts of process given off from them—short ones called dendrites, and a long single one from each cell called its axone. These processes travel hither and yon within the brain and cord, and some of the axones extend outward from them. A number of axones gathered together in bundles make up a nerve.

There are twelve pairs of nerves given off from the brain, called cranial nerves; and thirty-one pairs given off from the spinal cord, called spinal nerves. The nerves divide and subdivide until finally practically every cell in the body is in contact with nerve fibres of two sorts. One sort of fibre goes from each cell to the brain or cord (afferent) carrying sensations inward; the other sort leads outward from the brain or cord and carries impulses to stimulate the cells to activity (efferent).

Afferent nerves are also called receptors because they receive sensation; and efferent ones effectors because they produce action. The receptor, carrying sensation, always comes into contact with an effector. The ingoing impulse passes through its own cell and across to another cell. The whole principle of the nervous system is the translation of sensations received into action performed. The term synapse is used to describe

the point of transfer of a nerve impulse from the processes of one cell to those of another.

Sensation is of several kinds. There are, first, the special senses of sight, hearing, smell and taste. These are carried on

FIG. 40.—The base of the brain. 1. cerebellum; 2. medulla; 3. 12th cranial nerve (hypoglossal); 4. 3rd cranial nerve (oculo-motor); 5. pituitary gland; 6. 1st cranial nerve (olfactory); 7. frontal lobe; 8. 10th cranial nerve (pneumogastric); 9. 9th cranial nerve (glossopharyngeal); 10. 8th cranial nerve (auditory); 11. 7th cranial nerve (facial); 12. sensory root of 5th cranial nerve (trifacial); 13. motor root of same nerve; 14. 4th cranial nerve (trochlear).

only by special cranial nerves. Then there are sensations of touch, pain, and temperature that are carried on by nerves that are practically omnipresent in the body. One sort of

sensation of which the individual is usually unaware is that which comes from muscles and joints and gives the sense of position and motion. It is possible to tell by sensations,

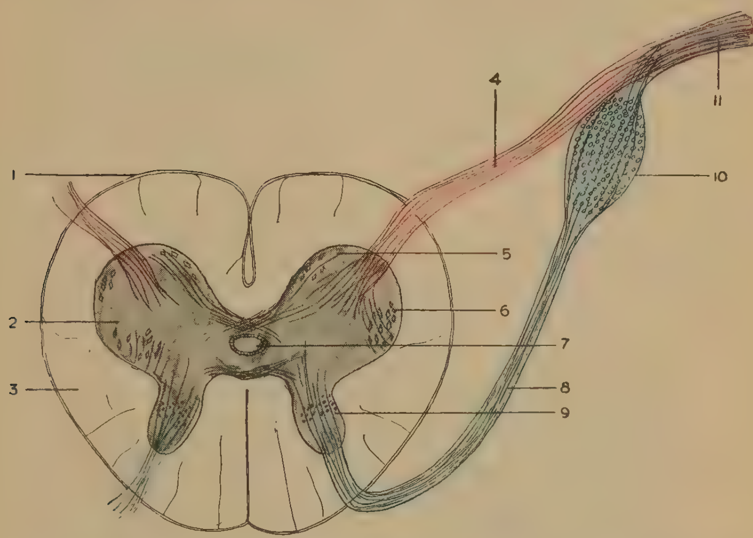


FIG. 41.—Transverse section of spinal cord. 1. meninges; 2. gray substance; 3. white substance; 4. motor fibres forming motor root of a spinal nerve; 5. anterior horn, containing cells from which motor fibres arise; 6. ganglia of cells; 7. central canal; 8. sensory root of spinal nerve; 9. posterior horn, where are cells from which sensory fibres arise; 10. ganglion on posterior root; 11. spinal nerve.

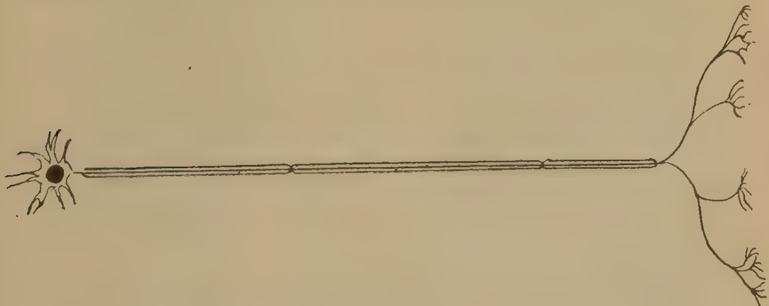


FIG. 42.—A neurone, showing cell body, dendrites, axone, and ultimate termination in nerve fibrils.

and without the use of the eyes, what the position of the body is and how it is moving. This is called kinaesthetic sensation. It is an important preliminary to the use of the motor nerves.

Fig. 43.—Taste buds at the back of the tongue. Arrow shows direction of sensory impulses toward the brain.

Fig. 44.—End-organ of olfactory nerves, to receive sensations of smell.

Fig. 45.—Touch corpuscle in the skin. (From Ritchie, "Human Physiology." Copyright 1908, 1915, 1920 by World Book Company, Yonkers-On-Hudson, New York.)

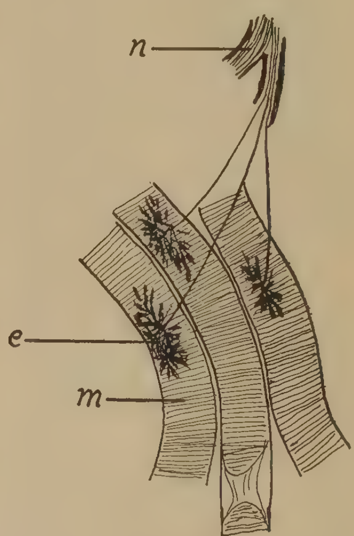


Fig. 46.—Motor end-organs in voluntary muscle fibres, through which the muscle receives impulses for motion. *n*, nerve; *e*, end-organ; *m*, muscle fibre.

Sensations may be divided into two groups—those that come from within the body itself and those that convey information to the body of its surroundings. The former are called proprioceptors and the latter exteroceptors. The former lead to adjustments made within the body, so that it works as a harmonious whole. The latter lead to adjustments made by the whole body or its parts in adapting to conditions about it.

Action is of two main sorts—motion and secretion. It may be considered also that the effector impulses are producing action of a sort when they stimulate the growth and repair process of cells (trophic action).

Action in a physiological sense has a meaning sometimes that is quite the opposite of what it is usually understood to mean.

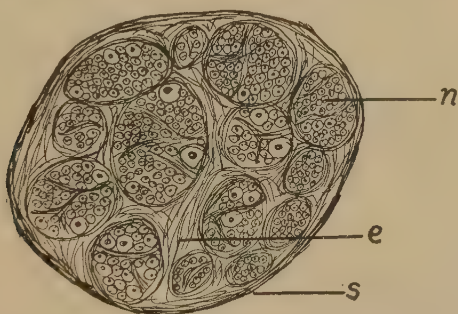


FIG. 47.—Cross section of a nerve, showing bundles of nerve fibres (*n*) held together by connective tissue (*e*) the whole surrounded by a sheath (*s*).

If overt action ceases, something stopped it. The force that stopped it is as much a force as that which started and continued it. Action of the nervous system means sometimes this restricting kind of force. The term inhibition is used to describe it. Organs may be supplied with nerves carrying activating impulses, as well as those carrying inhibitory impulses. It is by the balance between the two impulses that the regular rate of performance is maintained. Stimuli leading to inhibition of action change the performance as much as stimuli to greater overt activity.

In single-celled animals no nerves are required to make sensation produce action. The whole cell feels and the whole cell acts. In primitive multicellular animals only a few nerve

fibres are found. In higher animals the spinal cord exists and the system of incoming and outgoing nerves as described. Finally, in the highest animals (that are called cerebrate) the brain appears, as the latest and highest development of the nervous system, capable of still more complete adjustments to the outside world because of its function of consciousness.

In animals that have only a spinal cord, action takes place very simply on the reflex principle. A sensory stimulus goes

FIG. 48.—Median longitudinal section of the human brain. *A, B, C, D,* convolutions of the cerebrum. *E, F,* cerebellum. *H,* pons varolii. *K,* medulla. (From Hough & Sedgwick, "The Human Mechanism." Courtesy of Ginn & Co., Publishers.)

in to the cord, is transferred to an effector cell and travels out to an organ to make it act. Man acts according to the reflex principle to a great extent. But man also has the power of considered action. This is made possible by the travelling of the sensory impulse as far as the brain, where it is perceived and thought about and acted upon deliberately.

Thought is made possible because of the storage in the brain of many past sensations and memories of many kinds. The incoming sensation goes not directly to an outgoing cell, but is flashed around through many cells, forming all sorts of

associations before action is determined on. The reflex travels through only a few cells, whereas conscious action is produced by the travelling of the nerve impulse through an intricate route, in which it activates and produces integrations among a number of cells.

An illustration of the reflex is the quick withdrawal, without thought, of the finger when it touches a hot iron, for example; or of coughing involuntarily when the sensation is felt that indicates unconsciously that something must be removed

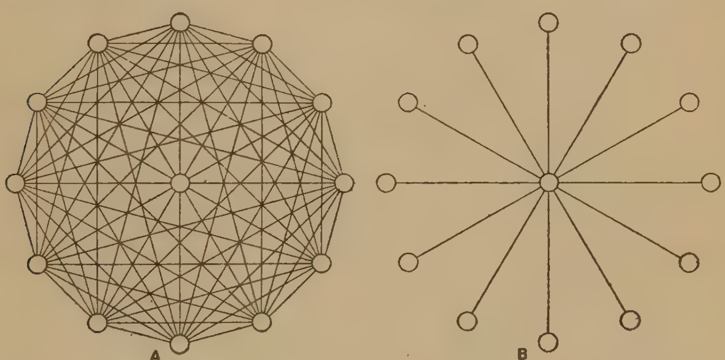


FIG. 49.—*A* shows the number of wires necessary to connect twelve houses by telephone without a central office. *B* shows the number of wires necessary to connect the same number of houses through a central office. The number of nerve fibres that would be necessary to connect all parts of the body without a brain and spinal cord to act as a central office can hardly be imagined. (From Ritchie, "Human Physiology." Copyright 1908, 1915, 1920 by World Book Company, Yonkers-On-Hudson, New York.)

from the trachea or throat; or of tears that come on hearing bad news or on thinking of something sad. It is to be noted in the latter connection that thoughts start not only considered action but also reflex action. The student will be able to supply his own illustrations of sensations that travel to the brain and result in conscious deliberate action.

The cerebellum, although classed as a part of the brain, takes no known part in consciousness. Impulses that reach it are acted on reflexly. They are largely concerned with the acts that maintain equilibrium.

Some of the sensations that go all the way to the brain are still not perceived but are acted upon reflexly. On the whole,

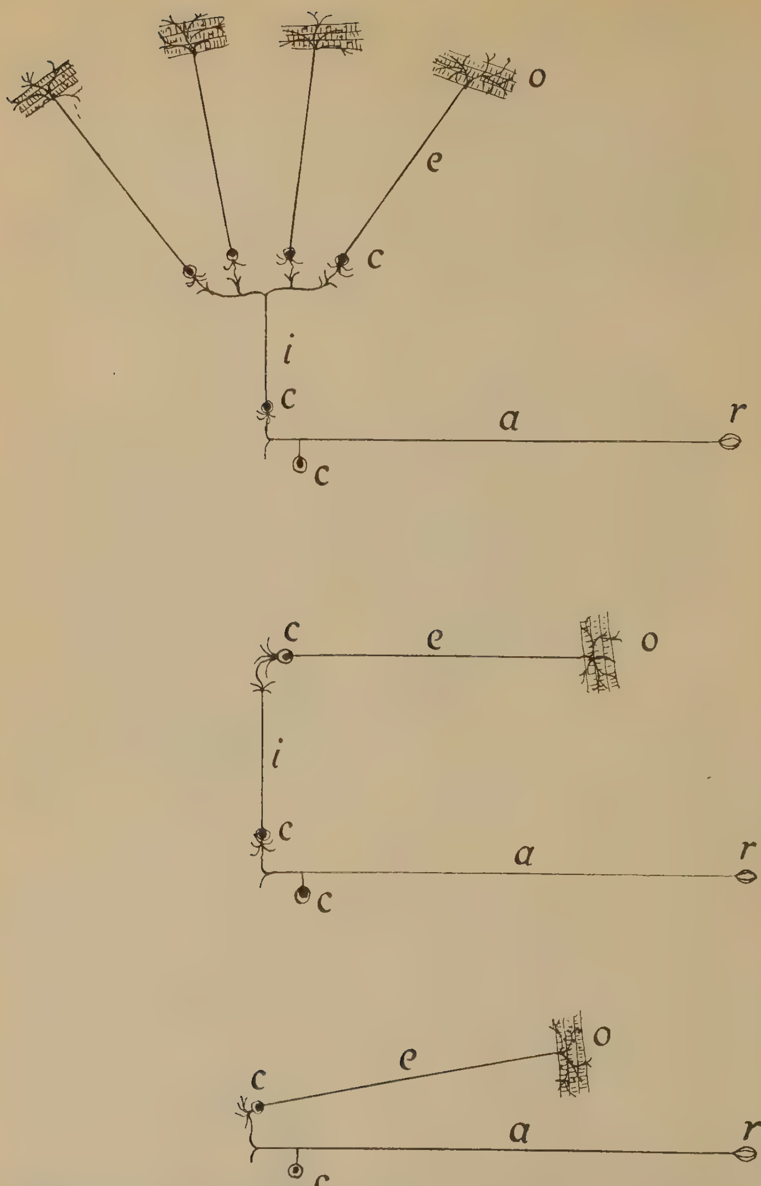


FIG. 50.—Three types of reflexes. *r.*, receptor; *a.*, afferent neurone; *c.*, cell body; *e*, efferent neurone; *o.*, end organ in muscle fibre; *i.*, intermediate or association neurone.

consciously determined action following conscious perception forms a small part of life in proportion to the total activity of man.

FIG. 51.—Diagram of reflex action. *a.*, receptor; *b.*, afferent neurone; *c.*, cell body; *d.*, synapse; *e.*, association neurone; *f.*, synapse; *g.*, association neurone; *i.*, efferent neurone; *j.*, end organ in flexor muscle of arm.

Most of man's bodily activity is not conscious. The activity of all of the organs depends on sensations received by the nervous system that are in the main not perceived, and the

FIG. 52.—Tactile end-organs in the finger, for the receipt of the touch sensations. (From Halliburton, "Physiology," 15th Edition.)

action that results is itself not perceived. It is fortunate that this is so, since even the wisest physiologist would not know how to interpret the messages from his individual cells or how to act on them. For the purpose of governing this

visceral (organ) activity, the higher animals have retained a mechanism that is characteristic of very primitive animals.

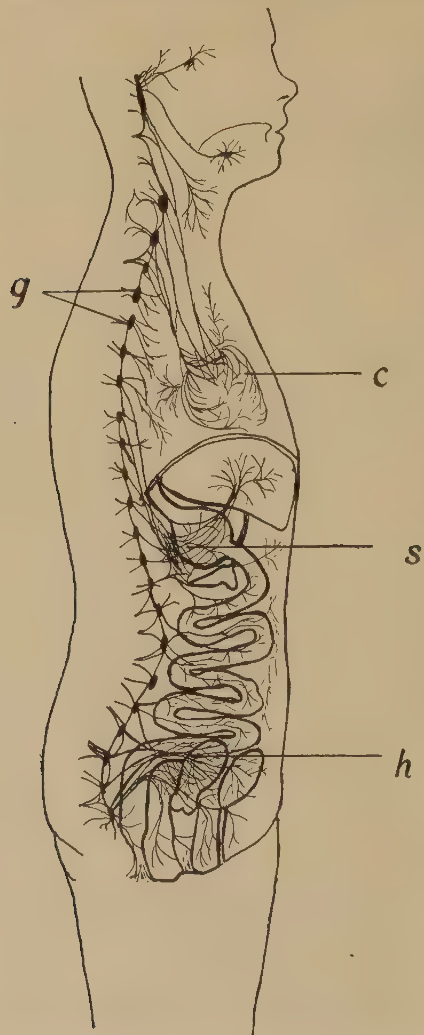


Fig. 53.—Autonomic nervous system. *g.*, spinal ganglia; *c.*, cardiac plexus; *s.*, solar plexus; *h.*, hypogastric plexus.

The vegetative nervous system, as it is called, is all the nervous system some animals have. In man it consists of

ganglia of nerve cells that are chiefly located in front of the spinal column. Into the ganglia come fibres from the spinal cord, giving them indirect connecton with the brain. This vegetative or autonomic or sympathetic system is not entirely cut off from the brain, but in the main the sensory impulses from organs are not perceived unless they are violent or unpleasant. The activity of the organs goes on reflexly in such a way that it needs no conscious direction. Sometimes sensations and motions produced in organs are perceived, as, for example, hunger or a stomach ache.

In connection with the various systems of the body, autonomic nerve action is discussed in greater detail. It should

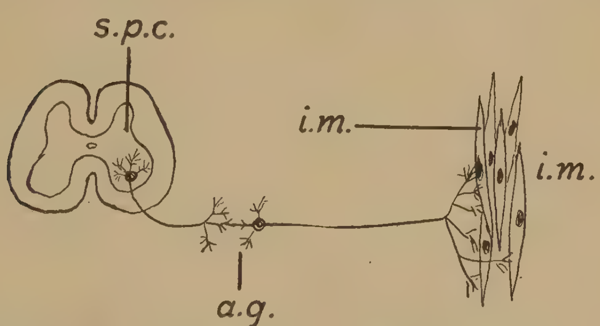


Fig. 54.—Diagram of a sympathetic reflex. *sp.c.*, spinal cord; *a.g.*, autonomic ganglion *i.m.*, involuntary muscle.

be noted here, however, that as in the case of cranial and spinal nerves, thoughts have power to influence the response. Emotions are always accompanied by some change in visceral activity. In fact, the motor activity of the stomach, for example, can be entirely stopped by irritating emotions.

The forerunner of all action is sensation, which may be either present or past (memories) and which may be either consciously perceived or not. A sensation or a memory that leads to a given action is called the stimulus to that action. The resulting action, called the response, may also either be perceived or not. It also may be either voluntary or involuntary—the latter being reflex action by either the cranial or spinal nerves or by the sympathetic nerves.

Each neurone is in functional contact with many other neurones by the synaptic relationship of its dendrites and axones. There is a tendency for a nerve impulse from a given cell to pass over synapses it has passed over before. If a given sensation arouses a given response once, it is likely to do so again. This holds true in respect to any kind of bodily action and also in respect to conscious action. In other words, resistance at the synapse is lowered each time it is traversed. This gives the explanation of habit formation and of the ability to learn.

Some synapses have been traversed so many times in the history of the race that individuals are now born with certain synapses already open or ready to be opened at the receipt of the proper stimulus. These inborn tendencies to action are called instinct. They are the habit of the body to act in particular ways, and are concerned largely with the actions necessary to preserve life and to preserve the race. Such acts are performed, we say, by instinct. Because these acts are necessary, their performance becomes associated with pleasurable feelings, and the thwarting of them with discomfort and unpleasant ones. The stomach contracts, sensations of hunger are felt and one "instinctively" eats.

Other synaptic connections that are made without effort are those that produce reflexes. Still others one acquires by habit. Having performed a certain response to a given sensation several times, it is likely that that sensation will continue to produce the same response, and a habit be formed. Thought and learning are made possible because of the ability the cerebral neurones have of making synaptic connections of many different kinds in orderly relationships and of retaining these associated memories for future use.

Certain parts of the nervous system preside over certain functions, although not without close relationship with many other parts. It has been shown that the sympathetic system (autonomic) presides over organ activity. Among its most important functions is that of the vasomotor nerves that determine the calibre of the blood vessels and thus of the supply of blood to organs and mucous membranes and the skin. Equally important is the regulation of the contraction of

smooth involuntary muscle such as occurs in the alimentary tract. Nerve fibres from this system also act directly on the secreting epithelium of skin, mucous membranes and glands.

The affector or sensory impulses that precede the action of the sympathetic system have their centers largely in the upper end of the spinal cord, the medulla. It contains centers which receive impulses from all parts of the body and thereupon regulate the most vital processes of organ activity—including all those mentioned as well as that of breathing and the heart beat. The visceral processes of all sorts carried on by the autonomic system are affected by the sensations received in these centers. Some of the centers are also affected by the chemical qualities of the blood circulating through them, so

Fig. 55.—Vasomotor nerve from spinal cord and autonomic ganglia to the wall of a blood vessel.

that they affect organs in various ways. For example, it is thought that the respiratory center in the medulla is activated to increase the rate of breathing when too much carbon dioxide is present in the blood passing through it, increasing the blood's acidity.

The spinal cord attends largely to sensations from the body as a whole and the action of the voluntary muscles—giving either voluntary or reflex action in them. It is both a center where reflex action originates, and a pathway to and from the brain, where voluntary action originates.

The brain has centers for the control of voluntary motion and for the receipt of sensory impulses from all over the body. It has also centers for the receipt of sensations of sight which enter by the optic nerve, and of sound which enter by the auditory nerve, and of other special sensations.

Much of the brain is engaged in receiving sensations and starting activity. But part of it is engaged in making associa-

tions between incoming and outgoing impulses. The function of the association neurones in the brain is the mysterious function of perceiving and thinking and imagining and remembering and feeling and willing.

One of the most important aspects of the mental life—that of willing—is both positive and negative. The brain has a reflex inhibitory action on the activity started elsewhere in the body, and it also has a conscious inhibitory power. The brain developed as a further means of controlling action, which, in its absence, would be purely reflex. Its control is exerted in these two ways, by promoting action and by preventing or inhibiting it.

The sum total of all the psychic or mental processes is normally in the direction of the more perfect working of the body itself, more perfect adjustment of the individual to the conditions in which it lives, and, finally, the improvement of the conditions themselves. Animals that lack well-developed brains are at the mercy of their instincts and reflexes and habits. The most highly developed cerebrate animals are able by the use of the brain to enhance the value to them of instincts and reflexes and habits and at the same time to enchance for themselves the value of their environment.

CHAPTER X

THE CIRCULATORY SYSTEM

Just as one finds nerves everywhere in the body, so one finds blood vessels everywhere. It is necessary that there be a fluid circulating medium in order to distribute the products of one part of the body to other parts where these products are useful; to transport the digested and absorbed food to all of the cells; to carry to each cell the oxygen it needs to oxidize its food and produce its energy; to carry away from the cells whatever they have produced that should be removed from them and from the body.

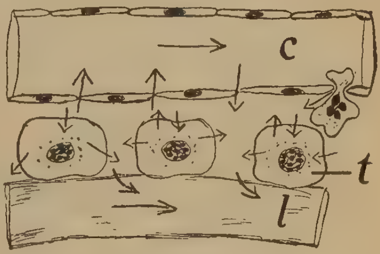


FIG. 56.—Nutrition of cells. *t.*, tissue cell, *c.* capillary, *l.*, lymph vessel.

The circulatory system may be likened to a transportation system carrying many sorts of freight, loaded in one part, to be unloaded elsewhere. The loading and the unloading go on as the result of the chemical characteristics of the cells, that cause certain substances to diffuse into them and others to diffuse out of them.

The circulating blood is also the medium whereby the body heat is distributed between the warm and the cool parts of the body. Body temperature could hardly be controlled in any other way so well as by the circulating of a warmed fluid to areas where it can be cooled.

The blood is pumped by the heart, which is a hollow muscular organ situated under and to the left of the sternum in the thorax between the two lungs. There are four cavities in the heart. From one of them, the left ventricle, leads the large blood vessel that supplies the whole body with fresh blood.

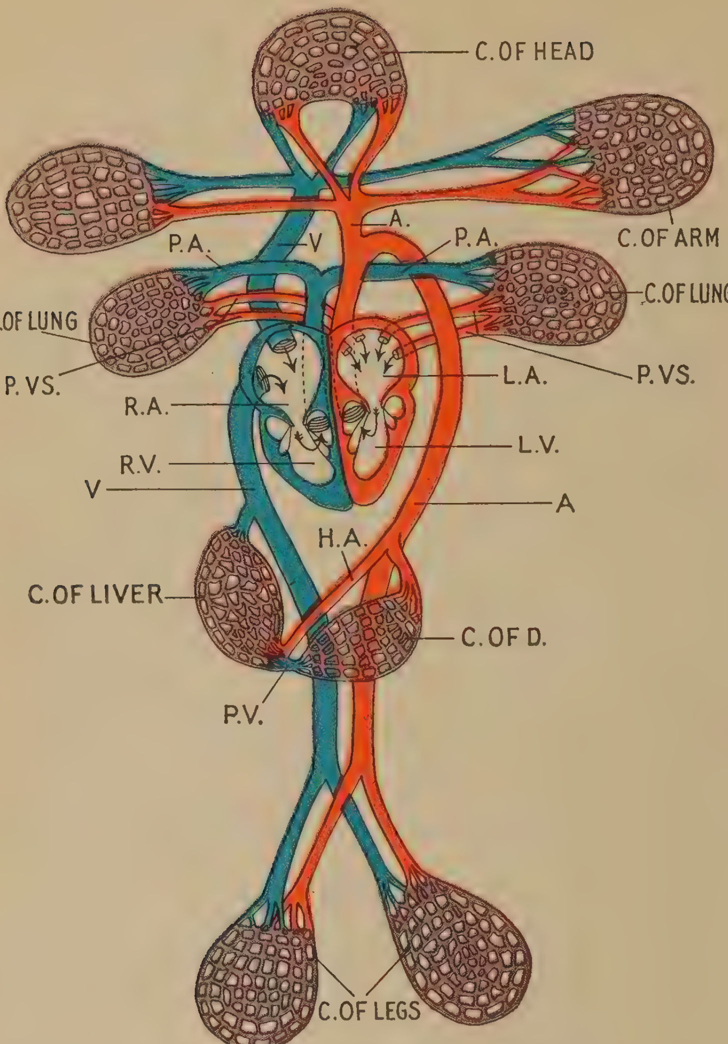


FIG. 57.—The circulation. *R.A.*, right auricle; *R.V.*, right ventricle; *L.A.*, left auricle; *L.V.*, left ventricle; *A.*, auricle; *V.*, vena cava; *P.A.*, pulmonary artery; *P.VS.*, pulmonary veins; *C.*, capillaries.

It is called the aorta. It gives off many branches, called arteries, that divide finally into the millions of minute vessels called capillaries. After interlacing among the cells these capillaries unite and form larger vessels, the veins. They carry the waste from the cells. The veins finally empty again into the right auricle of the heart. This is called the systemic circulation—fresh arterial blood from the heart through arteries to cells, and waste-bearing venous blood from cells back to the heart.

If the venous blood were to flow directly out to the body again it would not contain enough oxygen for the cells. It therefore makes a side trip to the lungs by means of the pulmonary artery, leaving the heart by the right ventricle. This artery divides into capillaries in the lungs. The blood there rids itself of carbon dioxide and takes on new oxygen. It then returns to the left auricle of the heart and starts on another circuit through the systemic circulation.

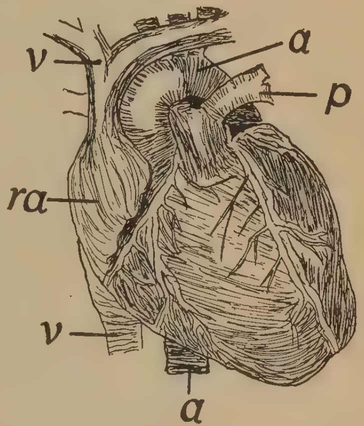


Fig. 58.—The heart. *a.*, aorta; *p.*, pulmonary artery; *v.*, vena cava; *ra.*, right auricle.

Both the pulmonic and the systemic circulations are going on constantly. Each time that the heart muscle contracts it squeezes the blood current anew in both of these directions. The left side of the heart with its two chambers cares for the systemic circulation and the two chambers of the right side care for the lung circulation. It is one long continuous circuit for the blood—out from the left side to the body and in at the right, out from the right side to the lung and in at the left.

There is a short circuit from the systemic circulation called the portal circulation. The veins from the intestinal absorbing areas lead directly to the liver where the food is worked over and some of it kept in the liver, the rest being sent directly

to the heart. This is in order to get the newly absorbed nutriment into circulation as fast as possible.

Between the heart and the aorta, and the heart and the pulmonary artery are valves of fibrous tissue to keep blood from flowing back, once it has gone through. There are also valves between the two chambers of the right heart and the two chambers of the left, for the same purpose. The ventricles

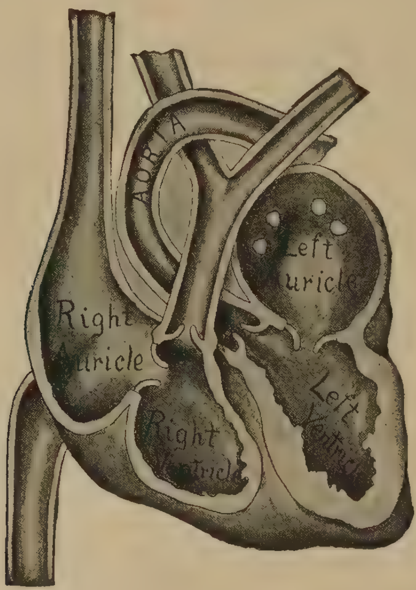


Fig. 59.—Chambers of the heart. (From Farr, "Internal Medicine for Nurses.") (Courtesy of Lea and Febiger Publishers.)

are the larger and more muscular chambers because it is from them that the blood receives its impulse to move outward from the heart. The two ventricles together in a day do an enormous amount of work. It has been estimated to be in the average adult from 300,000 to 400,000 foot pounds of work—that is, that they expend an amount of energy that would lift from 300,000 to 400,000 pounds one foot.

The auricles are chiefly receiving chambers, and need only enough power to keep the ventricles filled. The left ventricle is more powerful than the right because the blood must be

pumped out from it to the remote parts of the body, whereas the right ventricle merely has to pump the blood to the lungs.

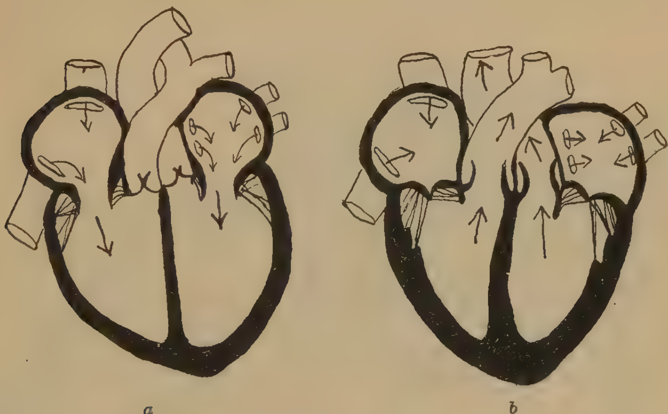


FIG. 60.—Diagram showing the course of the blood through the heart. Note opening of valves, *a*; and closure, *b*.

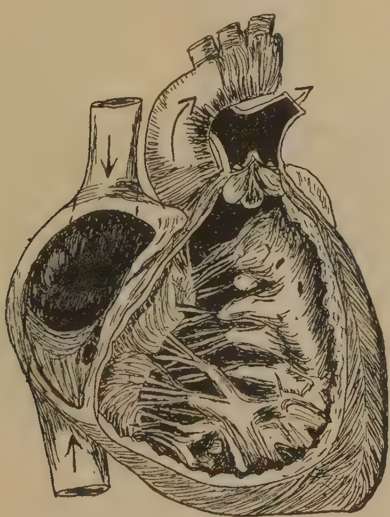


FIG. 61.—Interior of the heart. Note relative size of ventricle and auricle.

The contractions of the heart are the same as of any other muscle, except that they take place automatically about 70 to 75 times a minute. The apex beat of the heart may often be

felt by the hand on the chest. The sounds produced at the valves when the blood passes through and they close are of

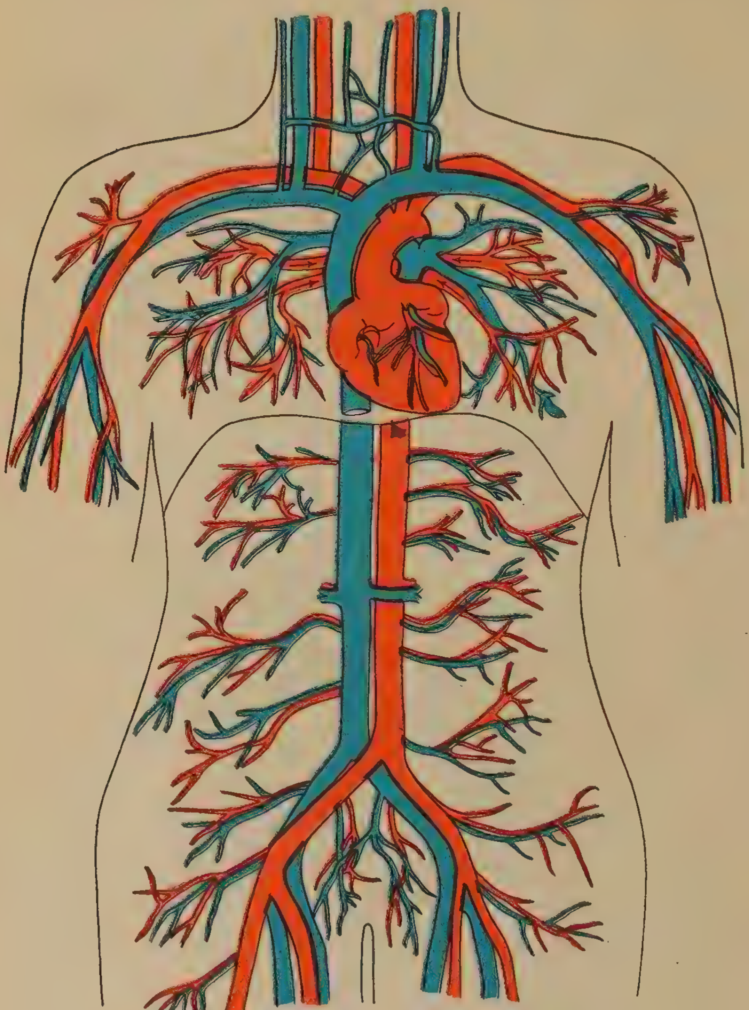


Fig. 62.—Diagram of the circulation.

interest to physicians. Many interesting facts about the quality of the heart muscle and the way it is doing its work

can be learned by listening to the heart by means of a stethoscope.

The heart is activated by nerve impulses of two sorts—one that makes it beat faster and another that makes it beat

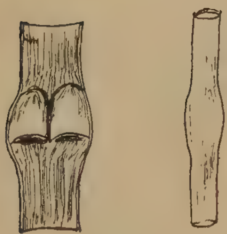


FIG. 63.—Vein opened to show valves.

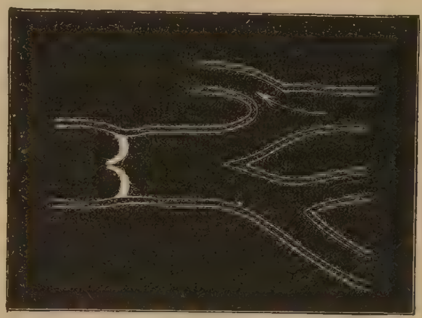


FIG. 64a.—Vein with valves closed. (From Halliburton, "Physiology," 15th Edition.)

more slowly It beats faster in exercise in order to supply blood to the muscles and lungs. The same effect may be produced by excitement. Ordinarily a weak heart beats faster

FIG. 64b.—Vein with valves open. (From Halliburton, "Physiology," 15th Edition.

than a strong one, to compensate by rate what it misses in strength of beat.

Since the heart beats all the time it would get no rest unless the rate were moderate enough for it to rest a little between beats. In the normal heart the resting period is longer than

the active period. This is all the rest the heart needs in order to function well through life.

If the heart is to be likened to a pump the blood vessels may be likened to a pipe system. Each time the heart contracts blood is sent onward through the arteries to the minute capillaries of every part of the body. The blood must then get back from the capillaries to the heart by means of the veins.

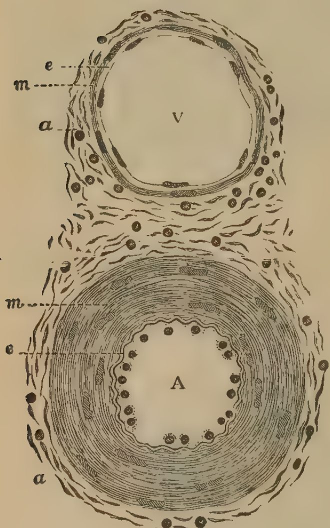


FIG. 65.—Transverse section through a small artery and vein. *e.*, endothelium; *m.*, muscle; *a.*, adventitia (connective tissue). (From Halliburton, "Physiology," 15th Edition.)

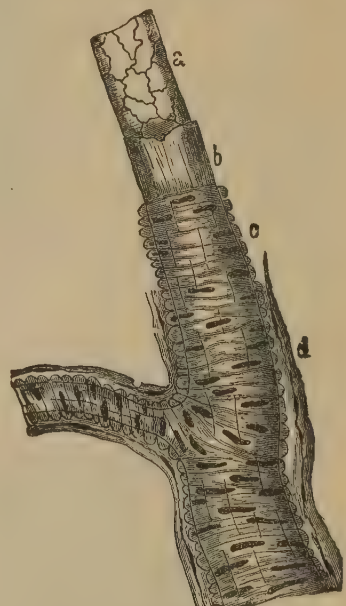


FIG. 66.—Coats of a small artery. *a.*, endothelium; *b.*, elastic layer; *c.*, circular muscle fibres; *d.*, outer coat. (Brubaker.)

It is here that circulatory problems become difficult, for the blood must travel often against gravity and without much of the pump-like force of the heart behind it. Although it is aided to some extent by the oncoming blood behind it, its onward push is rather feeble, since in no one capillary is there more than a tiny fraction of the whole force of the heart beat.

The return of the venous blood to the heart is accomplished in several ways. First, there is a slight suction effect produced

in the heart when the blood moves outward, that encourages the blood from the veins to take its place. Second, the blood is squeezed onward in the veins when the skeletal muscles contract. There are valves in the veins so that the blood cannot go back. It must therefore go on. Third, when the chest moves in breathing it creates a suction on the largest

FIG. 67.—Rouget cells, plain muscle cells in capillary walls. (From Evans, "Recent Advances in Physiology.")

veins as they are about to enter the heart, that tends to draw the blood from below into these vessels. Muscle action and full breathing will be seen to be the chief means of quickening the circulation through the veins. It has already been mentioned that activity increases heart action and consequently the flow of blood through arteries. When blood is coming into

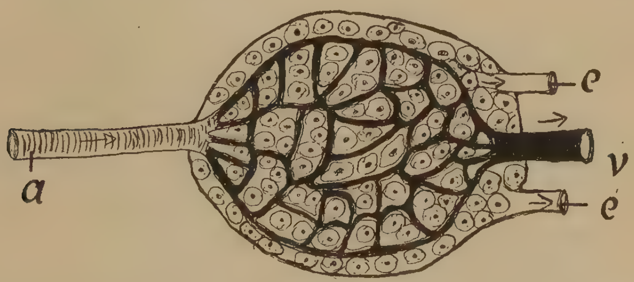


FIG. 68.—Gland and its blood supply. *a.*, artery; *v.*, vein; *l.*, lymph vessels.

a part rapidly and also leaving rapidly, its circulation is said to be good. The opposite is a condition called congestion, in which the blood either stands still or moves sluggishly.

The arteries have to bear the full force of the heart beat, and are consequently thicker and stronger than the veins. They are quite elastic, to enable them to recoil after the expansion

accompanying each heart beat. The pulse is the impact of the blood against the arterial walls. It may be felt in any artery that is near the surface—such as the radial artery in the wrist. The blood pressure in arteries is determined by the degree of pressure exerted on the arteries by the heart beat, and by the amount of resistance offered by the arterial walls. The highest blood pressure occurs when both factors are great.

In the arteries is also muscle tissue that enables them to change calibre according to the amount of blood needed in a given part of the body at a given time. These muscle fibres are controlled by the vasomotor and vasodilator nerves. They

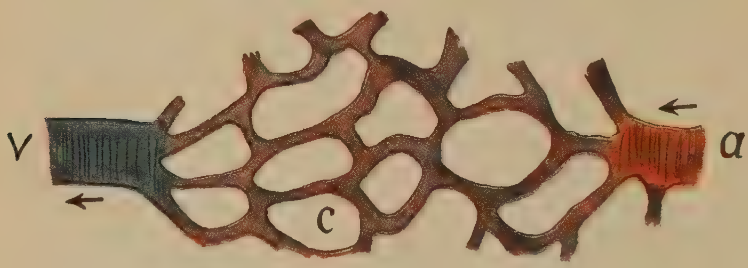


Fig. 69.—Blood vessels. *a.*, artery; *v.*, vein; *c.*, capillaries.

act reflexly and automatically in response to suitable stimuli, causing either constriction or dilatation of vessels. For example, the presence of food in the stomach causes these nerves to act in such a way as to increase the size of the blood vessels there and thus to admit much blood to the stomach. This is one of the most important principles of physiology, on which many of the rules of hygiene are based.

The ultimate circulation to the cells takes place from the capillaries. They are continuous very minute tubes connected at one end with a very small artery (arteriole) and at the other with a very small vein (venule). The blood always flows slowly through the capillaries. Fluid oozes from the blood to the cells and fluid from the cells enters the capillaries. There is always fluid about each cell, moving in either direction very slowly. This fluid is called lymph, and consists of material both from the blood and from the cells.

Not all of the fluid from the cells goes back into the veins. Some of it is carried away in vessels that arise in the lymph spaces about the cells. Some of these are at first merely spaces containing fluid, but the spaces unite to form channels, and these finally unite to form closed vessels similar to veins. Some of the carriers of lymph, called the lymphatics, are closed tubes from the start. They all gather together finally into two large ducts and empty into the veins near the heart.

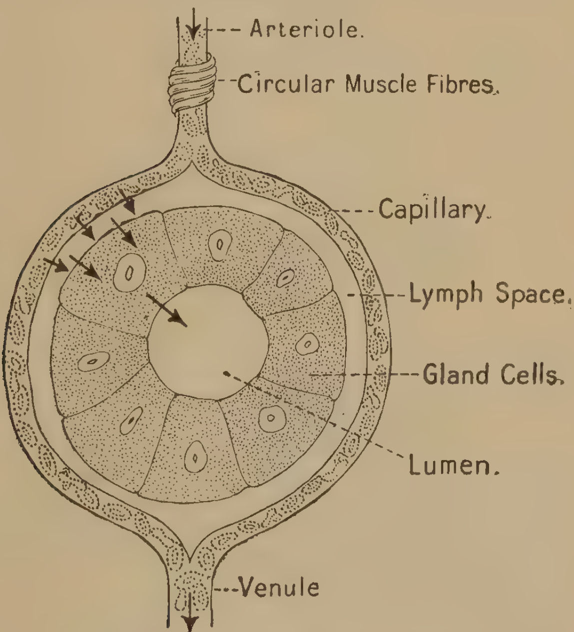


FIG. 70.—Secreting gland. (From Halliburton, "Physiology," 15th Edition.)

The larger one, the left thoracic duct, brings into the circulation some of the absorbed nutriment from the alimentary tract (the fats), its tributaries originating in the walls of the intestine.

Fluid from about the cells enters the lymph vessels and moves toward the heart because there is less pressure for it to overcome in moving in this direction than in any other. When crowded out from the cells it must go away from them, and it takes the line of least resistance. The flow of lymph is

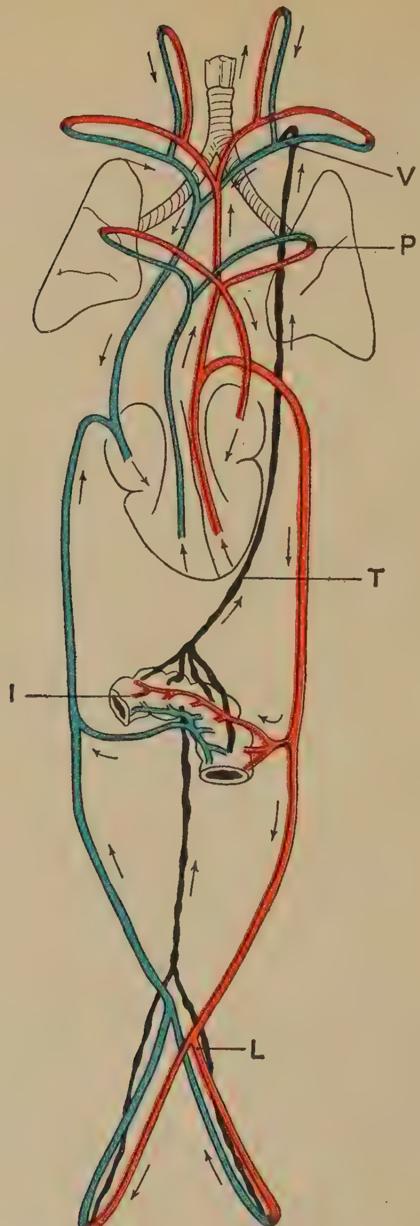


FIG. 71.—Diagram of the circulation, showing thoracic duct. *T.*, thoracic duct; *P.*, pulmonary circulation; *I.*, intestine with blood and lymph circulation; *V.*, vein in neck into which certain lymphatics empty.

very slow, but is promoted by the same causes as promote the return circulation of venous blood.

FIG. 72.—Lymphatic vessels.

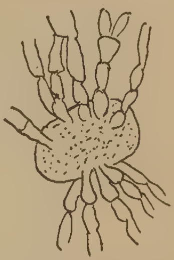


FIG. 73.—Lymph node with lymphatics.

Along the course of the lymph vessels are structures known as lymph nodes. They may often be felt in the neck. When the waste material that the lymphatic vessel is carrying

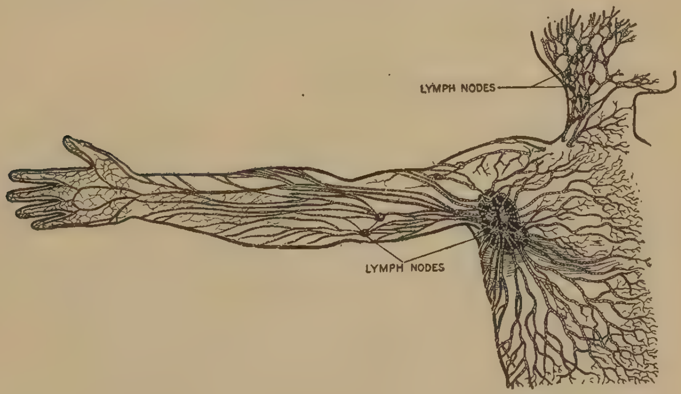


FIG. 74.—Lymphatic vessels and nodes. (From Ritchie, "Human Physiology." Copyright 1908, 1915, 1920 by World Book Company, Yonkers-On-Hudson, New York.)

reaches a node, it may be caught and held here until it is destroyed by phagocytic ("devouring") cells there. This is a valuable device to prevent harmful material such as bacteria from getting into the general circulation.

The blood itself is composed of a fluid called plasma in which float three kinds of cells or corpuscles—red cells, white cells, and platelets. There are about four or five quarts of blood in the body.

The plasma is the vehicle for carrying everything the blood carries except the oxygen, which is carried in the red cells, and some of the carbon dioxide which is also carried by the red cells. It gives off to the cells water and food substances. It takes from them their waste. The same plasma is offered to all cells, but each of the various kinds of cells takes what it needs to build up its own protoplasm, to make its own particular kind of secretions or excretions, and to exhibit its own kind of energy. The brain cells do not take exactly what the liver cells do; nor do they give back to the blood exactly the same waste, although carbon dioxide and water and nitrogenous compounds are constant waste products. In the plasma are contained the substances produced as the result of infection—first the toxins from bacteria and later the substances the body has made to neutralise the toxins, the anti-bodies against bacteria. In the plasma are carried the substances called hormones that are made in one part of the body and used elsewhere.

The plasma contains fibrin and has the ability to coagulate under conditions that prevail chiefly when blood escapes from its vessels. It is by this process of clotting that serious results from hemorrhage are prevented. It is thought that the smallest blood cells, the platelets, have some function to perform in clotting.

The red blood cells are found in large numbers in the blood, 5,000,000 per cubic millimeter. They are constantly being formed in the red bone marrow. Their number varies markedly according to the state of the health. The function of the red cells is to carry oxygen from the lungs to the body cells. This they are able to do because they contain a substance called hemoglobin which has an affinity for oxygen. It is the iron in hemoglobin that gives it this affinity. The cells, however, have a still greater affinity for oxygen, and the red cells give up the oxygen to them. A decrease in the number of red cells or in their hemoglobin content is called anemia. As has been mentioned, the red cells carry some of the carbon

FIG. 75.—White blood cell. *n.*, nucleus.

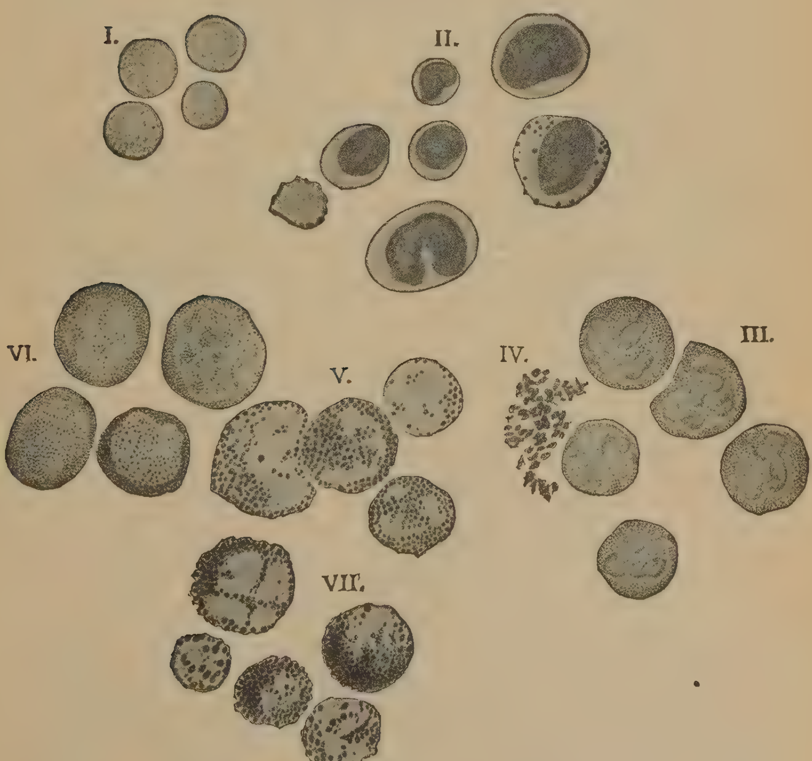


FIG. 76.—Blood corpuscles. I, red corpuscles; IV, platelets; II, III, V, VI, VII, various white corpuscles. (Bachmann and Bliss.)

dioxide also, although not in combination with hemoglobin. The spleen is an organ at the upper right side of the abdomen which is chiefly concerned in renewing the quality of the blood by taking out the old red cells and saving the hemoglobin.

The white blood cells are of several different varieties. They are constantly being destroyed and reproduced, like the red cells. One variety of them, the leucocytes, have the power of leaving the blood vessels by means of a sort of motion possessed by the amoeba. It consists of a flowing of the protoplasm in one direction, accompanied by a change in the shape of the cell. After several such internal rearrangements in the cell, it has succeeded in changing its location. It then grows thinner and squeezes through the cells that make up the capillary wall. This it does, not of volition, but because it is chemically attracted outside the vessel. The process is called diapedesis. The purpose for which white cells leave the vessels is to exercise the function of phagocytosis. This term comes from the Greek work meaning to eat or devour. The leucocytes are therefore called phagocytes when they are performing this function. There are normally more of them in the blood when more are needed for this purpose. What they devour is usually bacteria that have gotten into the body, but they also remove other harmful products of inflammation.

CHAPTER XI

THE TEGUMENTARY SYSTEM

Under this heading are included the cutaneous membrane or skin, the mucous membranes, the serous membranes, and the synovial membranes. They all consist of one and sometimes many more layers of epithelial cells, situated on a basement

FIG. 77.—Stratified squamous epithelium such as composes much of the tegumentary tissue.

membrane which is called, according to the structure, sub-cutaneous, sub-mucous, or sub-serous.

All are secreting structures. In the body all nutritive substances, all secretions and all excretions pass through the epithelial cells of one of these structures. In respect to

secretion the tegumentary membranes resemble the glandular organs, which are also epithelial structures but are not membranes. Not all epithelium is secreting epithelium, but all structures that secrete do so because they are made of secreting epithelium.

The general principles of secretion have been outlined in Chapter VII. Either a whole surface secretes, because it is composed of glandular epithelium, or a whole gland secretes for the same reason.

The goblet cell is the simplest sort of epithelial cell which pours a secretion directly upon a surface. When gathered

Fig. 78.—Columnar epithelium. *m.*, mucous cell.

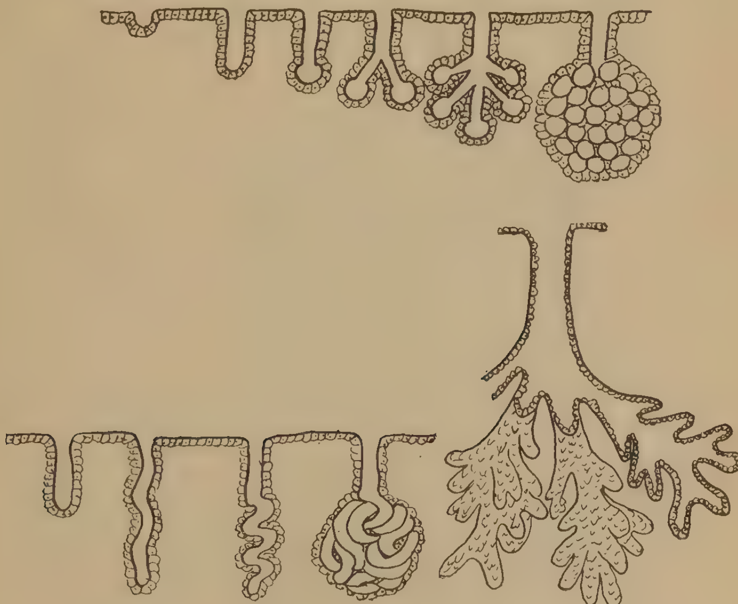
around ducts the shape is usually modified to a more nearly cuboid shape. One goblet cell is a gland in the true sense as much as the liver, which is an aggregation of millions of cells, the same in function as the goblet cell.

Membranes have three dimensions, but are usually only of very little depth. In glands the cells are grouped more economically as regards space than is the case in the membranes.

In order to increase the secreting surface of a membrane it may, besides the surface layer of goblet cells, have tubes, sacs, compound tubes, or compound sacs, that run beneath the surface. These are found in many of the tegumentary membranes. The skin, for example, contains elaborately coiled tubes which produce the sweat, and compound sacs that produce sebaceous material.

In the stomach and in the intestinal mucous membrane, there are also tubes as well as goblet cells

As has been seen, in the glandular organs there are enormous aggregations of compound tubes or sacs, each with a duct opening into a larger duct that may open finally upon a surface or may give their product directly to the blood stream.



b *c*

Fig. 79.—Various forms of glands. *a.*, ranging from a secreting surface to secreting tubes and sacs, and the compound saccular (racemose) gland, such as produces sebum; *b.*, secreting surface, tubular glands and coiled compound tubular gland, such as produces sweat; *c.*, cross section of compound tubular gland, such as produces saliva.

Secretions and excretions are produced in the same way. The difference is in the purpose for which they are produced.

Nutrition is carried on in a similar way. Substances get into cells in the intestinal canal and are sent out from them into the lymph or blood stream as though they were secretions of the gland epithelium.

All secreting membranes are alike in carrying on active chemical processes; in having free blood supply; and in having

ample nerve supply. In these three respects secreting epithelium exceeds all other structures of the body except the muscles.

The general functions of membranes are numerous. First, the membranes are for the protection of the body. This they do partly mechanically, as any covering protects that which is in it. They are also additionally protective because they contain sensory nerves which, by communicating with the

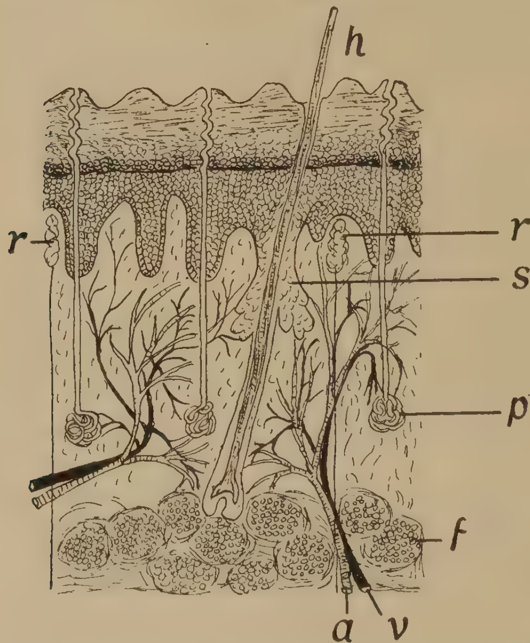


FIG. 80.—Cross section through the skin. *h.*, hair; *r.*, receptor (e.g. touch corpuscle); *s.*, sebaceous gland; *p.*, sweat gland; *f.*, fat or adipose tissue; *v.*, vein; *a.*, artery.

brain, acquaint one with the dangers that approach the body surfaces. Second, they are for the purpose of secreting materials that are physiologically of value to the body where they are secreted. Third, they are of value in that they carry on some degree of excretion from the body. Fourth, in some parts of the body they carry on absorption, notably in the small intestine. Fifth, the membrane on the outer surface of the body, the skin, is one of the most important structures in the

regulation of body temperature by providing a fluid that may be evaporated on the skin. Finally, the membranes have the function of respiration, in that they allow oxygen to pass through them. This is particularly notable in the mucous membrane of the lung.

The cutaneous membrane, the skin, has all of the functions mentioned except absorption and respiration, which take place, if at all, to a very slight degree. The skin covers the entire body and is continuous with the mucous membranes at the body apertures.

It consists of two main layers, the dermis, corium or true skin; and the epidermis or cuticle. The latter is the outermost layer of the body. Together these layers are from 1/100 to 1/8 of an inch thick, the greatest thickness being on the parts of the body where the greatest wear comes.

The top layers of the epidermis are dead and translucent. It is the more exposed parts of the body or those that are subject to friction that carry the thickest layer of epidermis. It is the epidermis that rises above the fluid which is formed in a blister. Where there is excessive pressure, a very thick layer may be formed, as for example, a corn.

Fig. 81.—A gland and its blood vessels.

The deepest layer of the epidermis is called the Malpighian layer. It lies near to the dermis and grows because of the nutrition it gets from the dermis. The Malpighian layer is called the germinative layer because it consists of growing cells. As they grow they push outward toward the surface, flatten and die. It is in this layer that is found the pigment which gives skin its color.

The dermis or corium underlies the epidermis. It consists of a network of connective tissue fibres containing blood vessels and nerves and also some fat. The corium is the active part of the skin. In it are the sweat glands and sebaceous glands which pass upward through the epidermis to empty their fluids onto the skin. Also in the corium are found the roots of

the hairs together with the involuntary muscles that are attached to each hair root.

Aside from the endings of the nerves that give touch sensation, there are also the endings of nerves that carry sensations of temperature and pain. All of these nerve endings are near to the epidermis but not in it. There are also the nerves controlling the calibre of the blood vessels in the dermis and in its basement membrane. Finally, there are the nerves that control the secretion of its glandular structures, and nerves to control the muscles of the hairs.

Underneath the skin consisting of the epidermis and the dermis, there is the subcutaneous tissue which is of connective tissue containing some fat. In fact this tissue is one of the important fat storage places in the body. It is more utilized for this purpose in women than in men. This layer of fat is sometimes called the panniculus adiposus.

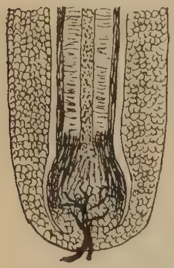


Fig. 82. — Cross section of a hair follicle, showing its blood supply.

From the corium, or even below it from the sub-cutaneous tissue, extend the hairs. The lowest part of each hair, its root, is a bulb-like structure from which extends upward the shaft which pierces the epidermis as it passes through. Hairs are analogous to epidermis in that they grow from below and are gradually pushed outward as growth takes place at the bottom. Hair gets its nourishment from the blood vessels near the root in the corium. The shaft of hair consists of three layers of horny cells that are dead. In the center of the hair is a substance called its pith. It is to be observed that the hair is not hollow. In the middle layer of the epithelium is the pigment or coloring matter.

About each hair is situated from one to three sebaceous glands opening upon the surface at the point where the hair does, secreting sebum to keep it and the skin flexible.

The nails are another variety of horny epithelial cells, much modified. The nails grow from the bed of corium lying beneath them, and from their roots which lie at the proximal end of the nail. The root is embedded in a fold of corium. The

cells in both the root and the bed of the nail are constantly multiplying to give the nail growth both in length and in thickness. If the nail is destroyed, a new nail will grow if the corium at the root is not damaged so as to destroy its cells.

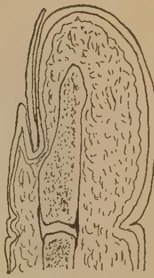


FIG. 83. — Cross section of the end of the finger showing the root of the nail.

In the skin are the sebaceous glands which secrete sebum, an oily substance for keeping the skin flexible and water-proof. The most important glands are, however, those that secrete perspiration, which is a fluid consisting mostly of water. It evaporates on the skin, and this cools the body. About two quarts of perspiration or sweat are excreted in twenty-four hours under ordinary conditions of moderate activity at moderate temperature, although most of this evaporates unperceived.

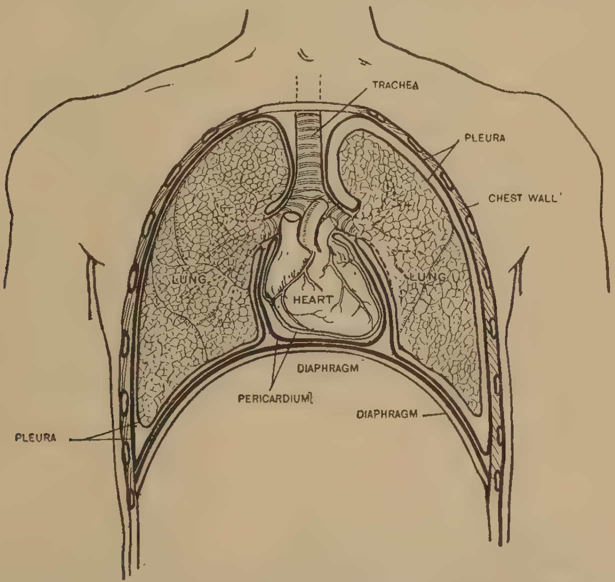


FIG. 84.—The pleurae. (From Ritchie, "Human Physiology." Copyright 1908, 1915 1920 by World Book Company, Yonkers-On-Hudson, New York.)

Perspiration is increased by nerve impulses that increase the amount of blood to the glands; and by other impulses that act

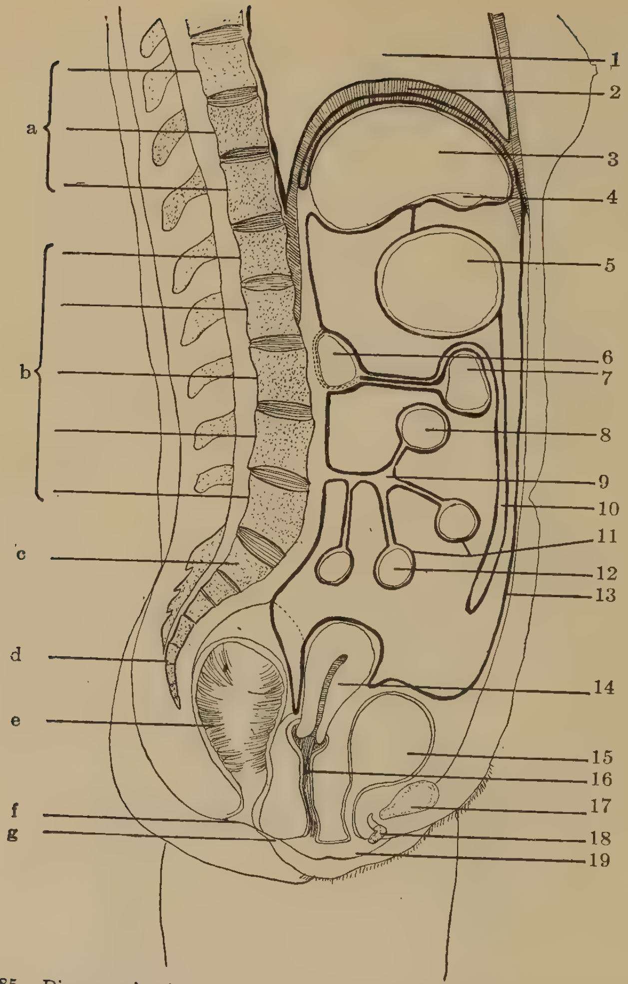


FIG. 85.—Diagram showing the peritoneum. 1. thoracic cavity; 2. diaphragm; 3. liver; 4. gall bladder; 5. stomach; 6. pancreas; 7. transverse colon; 8. jejunum; 9. mesentery; 10. great omentum; 11. visceral peritoneum; 12. ileum; 13. parietal peritoneum; 14. uterus; 15. bladder; 16. vagina; 17. symphysis (pubic bone); 18. clitoris; 19. vulva. a. dorsal vertebrae; b. lumbar vertebrae; c. sacrum; d. coccyx; e. rectum; f. anus; g. perineum.

directly on the glands themselves, increasing their secretory power. Stimuli usually originate in response to the need for body cooling.

The mucous membranes line all the internal surfaces that have access even indirectly to the atmosphere. They have glands that produce mucus, which is largely for the purpose of lubrication and moistening. In many parts of the body they also produce secretions unlike mucus that have special functions (e.g. digestive secretions of the intestinal tract). The mucous membrane of the whole respiratory and alimentary tract is one continuous structure. Another continuous sheet of mucous membrane is that that lines all the reproductive and urinary organs.

The serous membranes line cavities and cover organs that are entirely shut off from communication with the atmosphere. There are those serous membranes that cover the heart (pericardium) and lungs (pleurae) and the abdominal organs (peritoneum); those that line the thorax (pleurae) and abdominal cavities (peritoneum); and those that cover the brain and cord and line the skull and spinal canal (meninges). There is also serous membrane inside the heart (endocardium), and inside all the blood vessels (endothelium). All serous membranes secrete a little fluid. They are all for protection, and the lessening of friction between parts of the body when motion takes place.

The synovial membranes are a particular kind of serous membrane that lines joints, and are for the purpose of lubricating the joint surfaces. Tendons of muscles are also surrounded by synovial sheaths, in order that the tendon may slip smoothly in motion.

CHAPTER XII

THE RESPIRATORY SYSTEM

Since the body cells require oxygen, an apparatus is necessary whereby oxygen-containing air may be taken into the body in such a way as to make it available for the cells. External respiration involves the taking in of air. But respiration is not complete until the cells have taken on the oxygen. This is called internal respiration. The lungs and the tubes leading into them bring the air where oxygen may

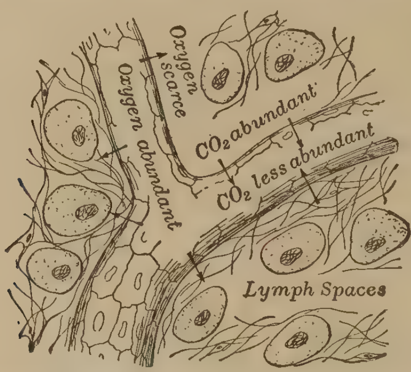


FIG. 86.—The exchange of oxygen and carbon dioxide between the blood and the lymph in the tissues. (Bachmann and Bliss.)

be taken up by the blood circulating through the lungs. The cells themselves then carry on internal respiration, helping themselves to the oxygen that is in the blood as it flows by them. The function of external respiration must be discussed first.

Included under the organs of respiration are all those parts of the body that serve to conduct air to the lungs, as well as the lungs themselves.

The apparatus begins at the nose, which is the main route for the entrance of air. The nose as a feature is somewhat

different from the nose as an organ of respiration. In addition to the part of it that is visible on the face, the nose consists of two long narrow, horizontal passages, the nares, separated by a bone and cartilage called the septum, and

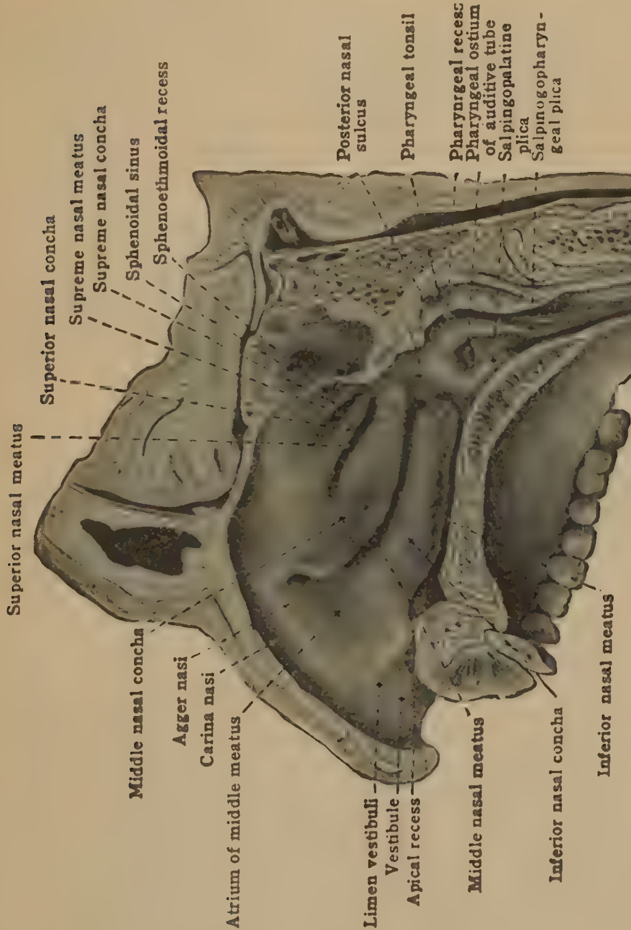


Fig. 87.—Lateral wall of the right nasal fossa and the naso-pharynx. (Bachmann and Bliss.)

communicating with a vertical passage back of both nose and mouth called the pharynx. The nasal cavities not only extend some four inches backward but also extend upward as far as the eyes. The part of the nose that projects from

the face is partly cartilaginous so that it will be more flexible and less likely to be broken. In the wings of the nostrils are small muscles that may sometimes be seen to become tense when an extra breathing effort is made. The floor of the nose is formed by the hard palate, which also forms the roof of the mouth.

The interior of the nose is lined with mucous membrane that is continuous with the skin. This membrane continues

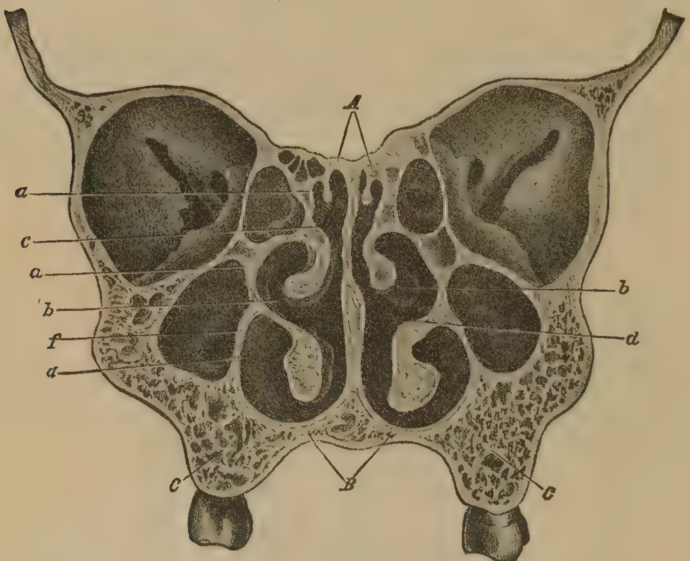


FIG. 88.—Transverse section, showing right and left nasal cavities, separated by the septum. *A*. roof of nose. *B*. floor of nose. *f*. outer wall. *C*. upper jaw. *b*. middle turbinate; *c*. olfactory region; *d*. respiratory region, near lower turbinate. (From Coakley, "Diseases of the Nose and Throat." Courtesy of Lea and Febiger, Publishers.)

all through the respiratory tract and in fact it is the same continuous sheet of membrane that covers the eye surface, the middle ear and the digestive tract as well as all parts of the respiratory tract. It is glandular epithelium which produces a fluid secretion that is of value in washing away dust and foreign particles that get on it from the inspired air. The mucus increases in amount in response to an irritant such as dust, in order that the respiratory passages may

be kept cleansed by the flow of mucus. Bacteria are dealt with in somewhat the same way.

In order to give a large surface of mucous membrane there are three bones projecting into the nasal cavity on each side, called the turbinates. They are irregular, twisted bones that provide additional mucous surface for warming and moistening the incoming air and catching extraneous matter.

There are two other devices for enmeshing material that should not be allowed to get into the lungs. First, there are

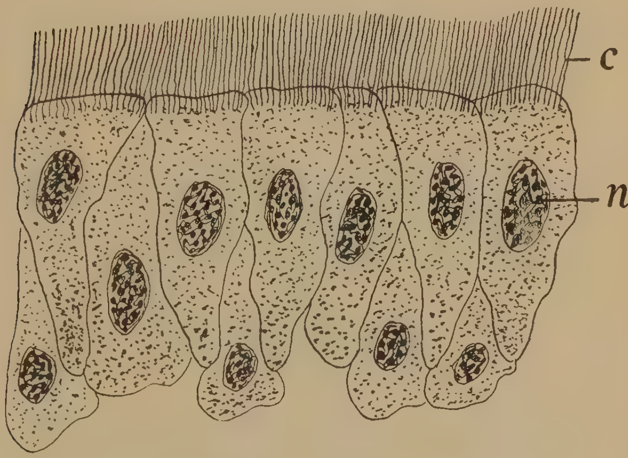


FIG. 89.—Ciliated mucous membrane. *c*, cilia; *n*, nucleus.

hairs in the nostrils, which act as filters. Second, there are cilia on the mucous membrane, fine waving hair-like processes that always wave from within outward. They not only catch particles, but help to move them outward, assisted in this by the flow of mucus. Throughout the respiratory tract there are cilia, except in the air sacs themselves and in part of the pharynx and on the vocal cords. They are not found in the mouth, which is not properly involved in respiration, or on the hard palate.

The crookedness of the nostrils, and the irregularity of the turbinate bones offer obstacles to the further passage inward of

foreign substances, which are likely to be caught on some corner as they pass, and become enmeshed there.

The nose is known as the organ of smell, since it has in its upper part the endings of the olfactory nerve. The nose communicates with the orbit through the lachrymal or tear duct. An excess of secretion there flows down through the nose, or over the lids upon the cheeks. The interior of the nose is well supplied with blood vessels, that dilate readily in response to changes in quality of air, temperature and conditions in the body.

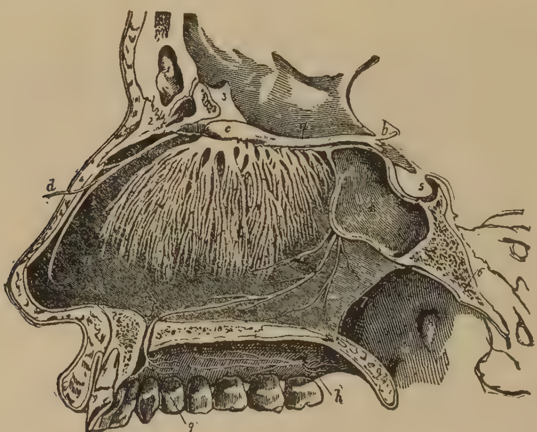


Fig. 90.—Cross section of the nose and mouth, showing nerves of smell and nerves to the teeth. (From Potter, "Compend of Anatomy.")

Communicating with the nose by ducts are the accessories of the nose called the sinuses. They are hollows in the frontal, ethmoid, sphenoid and maxillary bones, called by the name of the bone in which they are found. The frontal bone is the one which makes the forehead, the ethmoid is at the top of the nose, just in back of it, the sphenoid is back of the posterior part of the nasal canals and the maxillary bone is the one that forms the upper jaw. These hollows are for the purpose of decreasing the weight of the bones, and for increasing the resonance of the voice, which is largely determined by the size and shape of the nasal cavities themselves and of these sinuses. They are, however, also for the purpose

of supplying still more surface over which the air may pass to be warmed and moistened. They are lined with the same mucous membrane that lines the nose.

The pharynx is a cone-shaped, vertically placed cavity into which the nose and mouth open at right angles. The largest part of the pharynx is at the back of the nose and mouth. It tapers downward until it reaches the larynx below. It is called the naso-pharynx where it communicates with

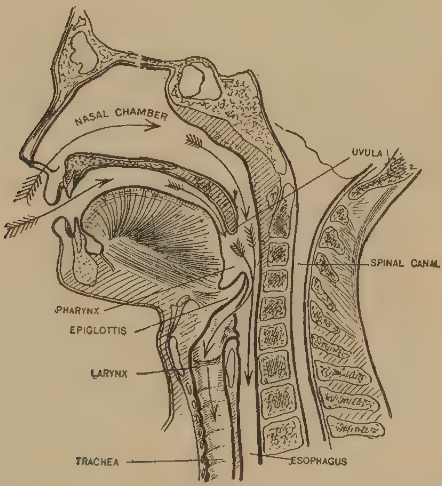


Fig. 91.—The route of air from the nose to the trachea, and of food from the mouth to the esophagus. (From Ritchie, "Human Physiology." Copyright 1908, 1915, 1920 by World Book Company, Yonkers-On-Hudson, New York.)

the nose; the oro-pharynx where it communicates with the oral cavity or mouth; and the laryngo-pharynx just before it reaches the larynx and oesophagus.

The naso-pharynx is that part which is back of and above the soft palate. The soft palate is the continuation backward of the hard palate, terminating in a small projection called the uvula. The soft palate is pushed backward and upward when swallowing takes place, so that food shall not go up into the nose. In the naso-pharynx, back of the soft palate, is located a collection of adenoid tissue which is normal in infancy, but usually shrinks away in childhood. It may,

however, grow to a larger size and block up the air passages and get infected, causing frequent colds and other difficulties.

At the sides of the oro-pharynx are the tonsils, which may usually be seen when the mouth is opened widely. They also are normal, and do not show the same tendency to shrink that marks the adenoid tissue. They are lymphoid tissue and their function is to catch foreign material, especially bacteria, and destroy it. If the tonsil holds too many bacteria, it may itself become diseased. The tonsil communicates with lymph nodes in the neck, which are inclined to enlarge when the tonsil is infected.

Opening into the oro-pharynx where they cannot be seen are the Eustachian or auditory tubes to carry air to the middle ear. These tubes are closed in ordinary breathing and open

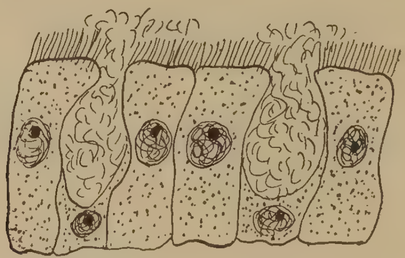


Fig. 92.—Mucous membrane of the trachea, showing cilia and mucous cells.

when swallowing or yawning takes place, at which times air goes into the middle ear. The larynx is directly below the pharynx into which it opens. The larynx is a box-like structure located in the neck, and has as its function that of voice production.

Besides the opening into the larynx there also leads downward from the pharynx the tube leading into the stomach, the oesophagus. There is a cartilaginous lid called the epiglottis, arranged so that it may cover the opening within the larynx, called the glottis. In swallowing, the epiglottis prevents food from being inhaled.

The larynx leads downward into the trachea, or windpipe. This is a tube about ¾ of an inch in diameter and about 4 or 5 inches long. It consists of fibrous tissue in which are

embedded 16 to 20 rings of cartilage, to hold the trachea open. The trachea lies close to the oesophagus. The trachea is lined with ciliated epithelium containing racemose (grape-like) glands, secreting mucus.

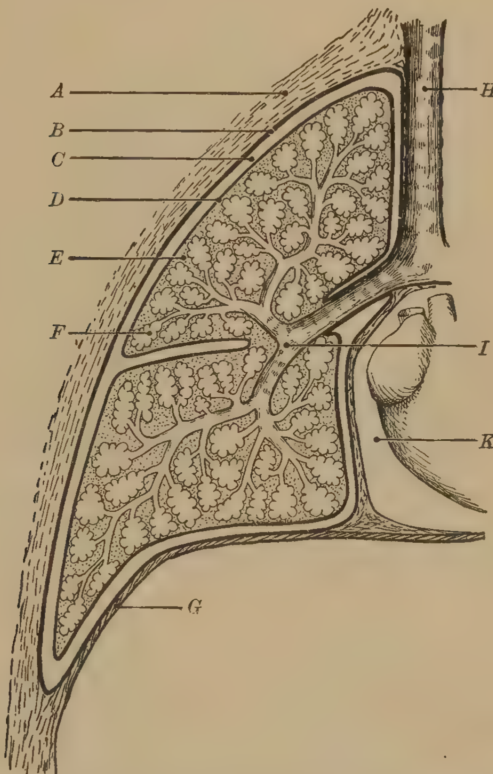


Fig. 93.—Diagram of vertical section of thorax. A, muscles, ribs, etc., of the body wall; B, pleura, lining same; C, pleural space or cavity; D, the pleural covering of the lung; E, connective tissue of the lung; F, alveoli, or air spaces of the lung; G, diaphragm; H, trachea; I, right bronchus; K, pericardial space, in which lies the heart. (From Hough & Sedgwick, "The Human Mechanism." Courtesy of Ginn & Co., Publishers.)

The trachea divides below into the two bronchi, one bronchus going to the right lung and one to the left. Each bronchus divides into smaller bronchi, and these divide and subdivide until the smallest bronchi, called bronchioles, are reached. Each of these communicates with a cluster of the

minute air sacs of the lung, of which there are perhaps three quarters of a billion.

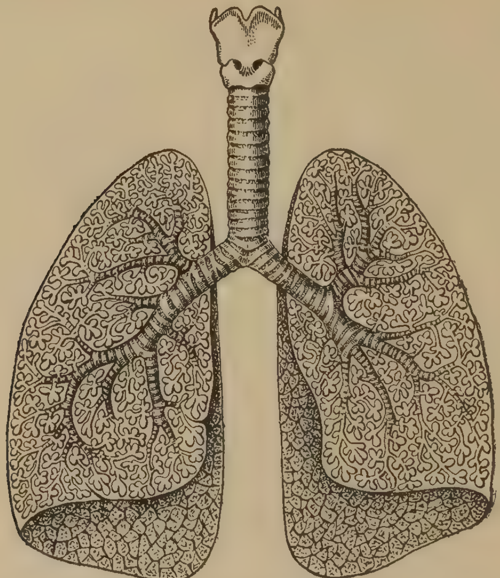


FIG. 94.—Diagram showing the larynx, trachea, bronchi and lungs. Note the final subdivision of the bronchi into lobules of the lung. (Bachmann and Bliss.)

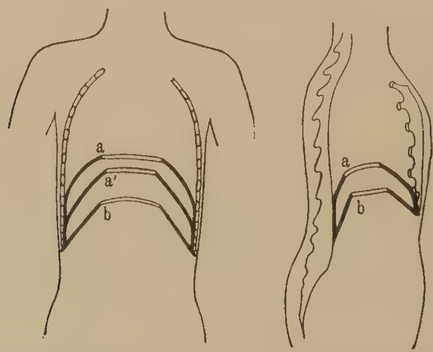


FIG. 95.—Diagram showing the position and shape of the diaphragm at rest *a* and during inspiration *a′* and *b*. (Brubaker.)

The lungs if examined grossly appear to be solid, but they are actually of the nature of a sponge.

The lungs, trachea, and bronchi fill the greater part of the thorax, the rest of the space being filled by the heart and the blood vessels entering and leaving it and the lungs. The lungs receive the blood they aerate through large vessels that enter them at the root near the place where the large bronchi enter. The lungs are covered with serous membranes called pleurae, which also line the chest, and permit frictionless motion in breathing.

In order to get oxygen into the lungs and carbon dioxide out it is necessary that the lungs expand and contract. This is accomplished by means of change in the capacity of the thorax. The lungs expand and air is sucked into them when they are stretched by an increase in the size of the thoracic cavity; and they shrink and squeeze air out when the chest capacity is reduced.

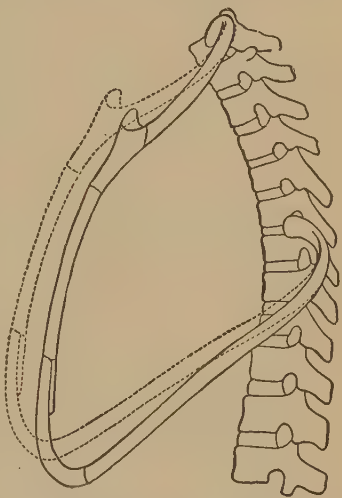


Fig. 96.—Diagram of first and seventh ribs, in connection with the spine and the sternum, showing how in inspiration the latter is carried upward and forward. The expiratory position is indicated by continuous lines, the inspiratory by broken lines. (From Williams, "Healthful Living." By permission of The Macmillan Company, Publishers.)

The muscles of respiration are those in the chest wall, particularly those between the ribs, and the diaphragm that stretches across its base. These muscles move partly automatically but are capable of training. They cannot be kept from moving (i.e. the breath "held") for more than a minute or so. The act of inspiration is the active part of breathing. Expiration is a passive collapse of previously stretched elastic lung tissue, although both acts may be forced voluntarily. The most successful breathing is that which utilises the muscles to increase the chest capacity in all dimensions.

After the air has entered each air sac the next step is the passage of the oxygen of the air into the blood. Close to each air sac are capillaries from the pulmonary artery. The

oxygen passes out of the air sacs through their walls into the blood because the ratio of tension of gases in the air sacs and the blood is such that the oxygen must go into the blood and the carbon dioxide must pass out. The red blood cells contain hemoglobin, a substance that has a great chemical affinity for oxygen, with which it straightway combines making oxyhemoglobin.

As the blood circulates through the body bearing oxyhemoglobin, the body cells that are low in oxygen offer a greater attraction even than hemoglobin does. The oxygen conse-

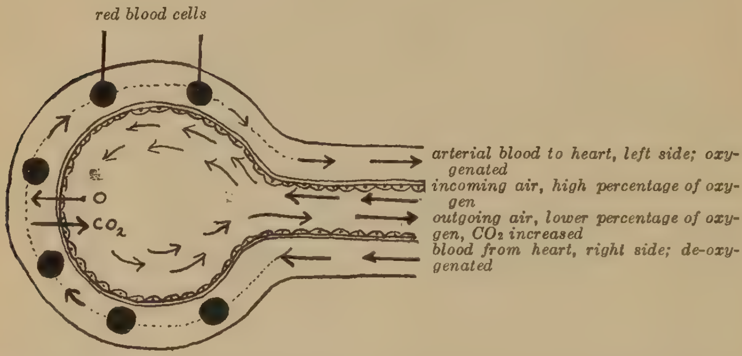


FIG. 97.—Diagram of an air sac of the lung surrounded by a blood vessel. Note the passage of oxygen into the lung and the blood, and the passage of carbon dioxide out of the blood and the lung.

quently leaves the hemoglobin and passes through the capillaries and the cell walls into the cells. At the same time carbon dioxide that has accumulated in the cells is given off into the blood to be carried to the lungs for elimination. The cells receive their oxygen from the arteries and give off their carbon dioxide by means of the veins.

Other gases in the ordinary atmosphere do not get into the blood, but there are some gases that are capable of doing so. This principle is involved in the use of anaesthetics, in which the gas (e.g. ether) passes into the blood and combines with tissues at the same time and in much the same way that oxygen does. Some of the poisonous gases act in such a way as to prevent oxygen from entering at the same time, and therefore interfere with cell respiration.

It should be mentioned that the need of the body cells determines the amount of oxygen they take up. In ordinary air there is always plenty of oxygen; in ordinary breathing

Fig. 98.—Diagram showing the relative tension of oxygen and carbon dioxide in the lungs, the blood and the tissues. (Brubaker.)

plenty of air is taken into the lungs. About a third of the oxygen taken in reaches the cells. Activity of the body produces a greater oxygen need; greater oxygen intake therefore occurs.

CHAPTER XIII

THE ALIMENTARY SYSTEM

The alimentary system consists of a number of organs, that combine in their activity to change the complex foods into

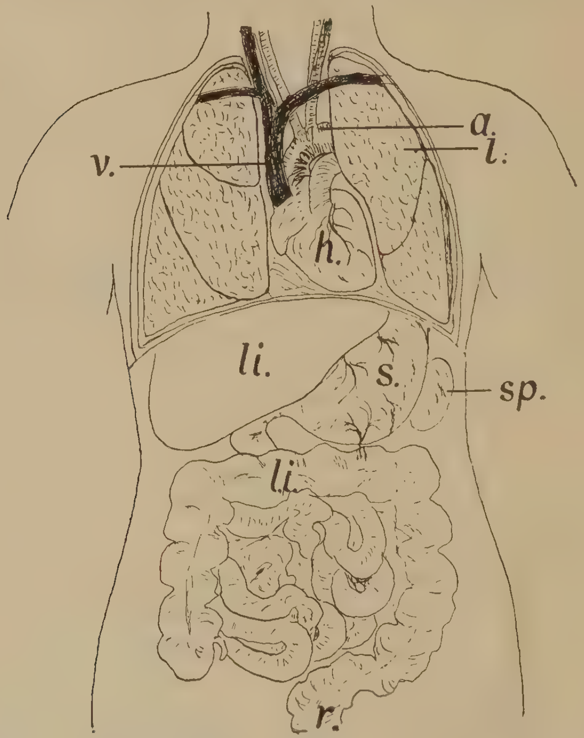


FIG. 99.—Vertical section of the body. *a.* aorta; *l.* lung; *v.* vena cava; *h.* heart; *li.* liver; *sp.* spleen; *l.i.* large intestine; *r.* rectum.

suitable nutriment for the body, and subsequently to absorb them into the blood stream. The food cannot be considered really in the body until the process of absorption has taken

place through the walls of the alimentary canal. Up until that time the food is within the body but not of it.

Food, as it is taken into the body, is usually a quite complex group of chemicals. The protein (carbon, hydrogen, oxygen, nitrogen, sulphur, etc.), the carbohydrate (carbon, hydrogen and oxygen) and the fat (carbon, hydrogen and oxygen) need quite elaborate changes before they can be absorbed or used by the body cells. The aim of digestion is to change these three substances, as they are found in food, into simpler chemicals of the particular sorts favored by the body cells.

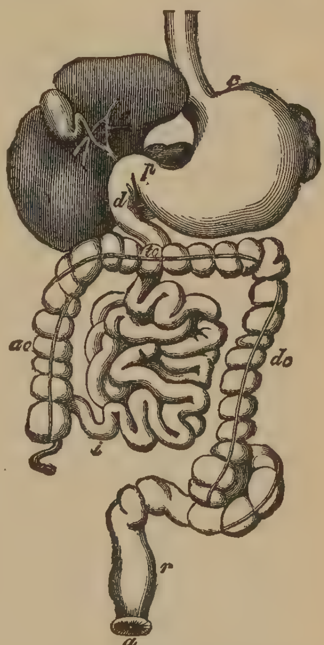


Fig. 100.—The alimentary tract, showing liver turned upward to expose the gall bladder beneath it. (From Potter, "Compend of Anatomy.")

The process of digestion is partly that of solution of the food by the fluids of the digestive tract, but it is more than that. In most cases it is also a complete change in chemical constitution, always in the direction of simplification to a few kinds of small molecules. Cleavage of molecules does not, however, reach the stage of simple elements.

In order to change the chemicals in food, several kinds of secretions are produced by the alimentary tract. These are called digestive juices. They contain enzymes as their active substances. Food cannot be wholly pre-digested by any chemical outside the body, although cooking renders some food more easily digestible.

The alimentary tract is a canal in all 26 to 34 feet in length, beginning at the mouth and continuing through the oesophagus, stomach, small intestine, large intestine and rectum to the anus. Throughout its structure is much alike, consisting of a mucous membrane which produces mucus, and in places also

digestive juices. The whole tract contains also muscle fibres, those in the mouth and tongue and those at the anus being under voluntary control, and the rest acting involuntarily. The stomach and intestines show very pronounced motion, which is a part of the means of aiding the digestion of the food as well as the means of moving it onward. Neither stomach nor intestines are firmly attached to the abdominal wall, but are able to change position with the change of body position, and with the changes going on within them. The bands of fibrous tissue that serve for their loose attachment to the wall are called the mesentery. Running through it are the arteries and veins and lymphatics that provide for nutrition and waste removal. There are also nerves, of course, that carry sensory impulses from the tract and bring in secretory and motor impulses.

The liver, gall bladder and pancreas have important functions in connection with digestion and nutrition, and are thus included under the alimentary system.

The digestive juices are fluids secreted from the cells in the walls of the tract itself and from the salivary glands, liver and pancreas. The active principle of any of the digestive juices is called an enzyme, a chemical produced by living cells, which takes part in chemical changes without itself being affected. The cells that produce enzymes do so because of an intrinsic power to take from the blood the substances needed, and to make the particular product they do. Their function is very highly specialized.

The secretory action of these cells is stimulated both by nerve impulses and by the presence of certain chemicals in the blood. The chemicals produced in one part of the body that have power, as they circulate in the blood, to excite functional activity in another part are called hormones. Among the hormones that excite the secretion of digestive enzymes are the recently absorbed foods. As soon as the slightest absorption begins, the further secretion of enzymes is stimulated. This provides for a long-continued period of digestion—the digestion that has gone on preparing constantly for more digestion. The gastric juice, the bile and the pancreatic juice are partly stimulated thus.

The various enzymes to be mentioned are selective in their activity—acting on only one variety of chemical substance, and carrying the cleavage of molecules only to a given point and not beyond. Some do not begin action until others have concluded their action. Some act only in an acid and some only in a neutral or alkaline medium. Except the saliva, the enzymes are not being constantly sent into the digestive tract, but appear when the presence of certain foods indicates that there is their sort of work to do.

The first part of the alimentary system is the mouth, where the first step in digestion takes place. The teeth are the means of subdividing the food, which must be accomplished in order to have the food in particles small enough so that it will not injure the stomach wall, and in order that it may be well mixed with the saliva.

The saliva is produced by three sets of glands—the parotid at the angle of the jaw in the front of each ear, the sublingual under the tongue, and the submaxillary under the jaw. All open by ducts into the mouth, from which on observation of the mouth the fluid can be seen to ooze. About three pints of saliva are produced a day—some at all times, but more when food is taken. The important substance in the saliva is ptyalin, which acts on starches, changing them to sugars. This action takes place largely in the mouth, but ptyalin carried into the stomach with starchy food continues to act on it while it is in the pouch of the stomach. Salivary secretion is stimulated by the sight and thought and smell of food and by the presence of food in the mouth, especially of dry food or of acid food. It is also stimulated by mere movement of the jaw. The ptyalin is alkaline and when it arrives in the stomach it helps activate gastric secretion. Nerve stimuli from the agreeable taste of food in the mouth also reflexly stimulate gastric secretion.

The stomach is a pear-shaped sac reached by the cardiac opening from the oesophagus. At its lower end it empties into the small intestine through the pylorus. At each opening is a sphincter which opens and closes at appropriate times. The stomach is a distensible reservoir for food, capable of holding two to three pints. It is located above the waist level normally, somewhat to the left of the middle line.

Paracelsus, at the time of the Renaissance, believed there was an archeus or spirit that dwelt in the stomach and separated the good food from the bad. It is now known that the action

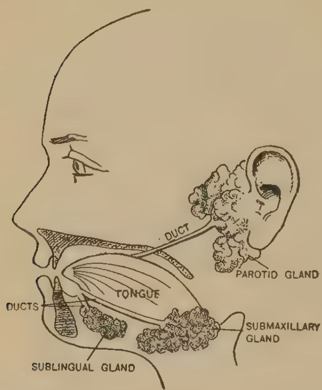


FIG. 101.—The salivary glands. (From Ritchie, "Human Physiology." Copyright 1908, 1915, 1920 by World Book Company, Yonkers-On-Hudson, New York.)

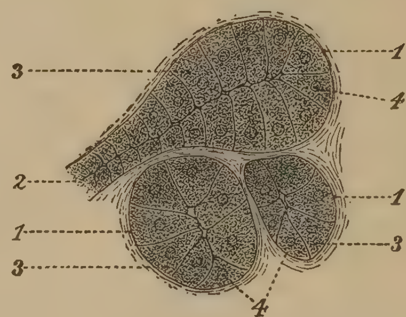


FIG. 102.—The parotid gland at rest. 1, acinus; 2, duct; 3, albuminus cells filled with granules; 4, nuclei almost concealed. (Semi-diagrammatic.) (Bachmann and Bliss.)

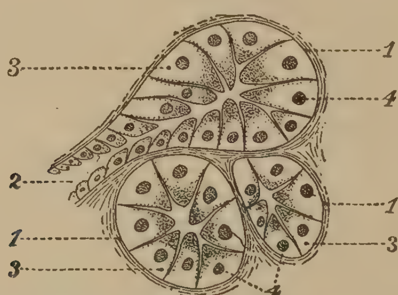


FIG. 103.—Parotid gland after prolonged activity. 1, acinus; 2, duct; 3, albuminous cells almost free of granules; 4, nuclei clear and well defined. (Semi-diagrammatic.) (Bachmann and Bliss.)

of the stomach is by its motion and its secretions. Its mucous membrane contains glands that produce mucus and several kinds of secretion. Its muscles run in several different directions and act constantly when food is present and when it is time to eat.

The gastric secretions that act on the food are chiefly hydrochloric acid, pepsin and rennin. They are produced by the glands in the mucous membrane, from material the glands take from the blood. The hydrochloric acid acidifies the food, activates the pepsin, and acts to some degree as an antiseptic on certain bacteria. When it gets into the duodenum with the food, it acts on the mucous membrane to produce a substance called secretin which is absorbed into the blood and acts as a hormone to stimulate the pancreas.

The most important gastric secretion is the enzyme known as pepsin, which acts on proteins, splitting the large protein

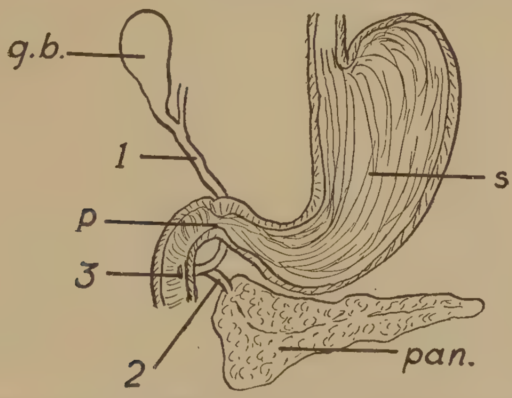


FIG. 104.—The stomach, gall bladder and pancreas, all communicating with the duodenum. *g.b.* gall bladder; *s.* stomach; *pan.* pancreas; *p.* pylorus; 1. bile duct; 2. pancreatic duct; 3. opening of the common duct into the duodenum.

molecules into smaller ones, called peptones. Pepsin-containing food, when it reaches the intestine, advances the work of enzymes there.

The rennin in the gastric secretion acts exclusively on the protein of milk (casein), which it coagulates. The semi-solid milk protein is then acted on as the other proteins are. There is also a less significant secretion of the stomach called lipase, which acts somewhat on such fats as cream and butter.

The gastric secretions are not constant, but are produced at need, according to the food eaten. They, too, may be stimulated psychically. They tend to begin at the regular time for food whether one eats or not. The gastric juice is not of

constant composition, but varies with the state of the health and with the food eaten.

The combination of chemical and mechanical action in the stomach makes the food into a mushy substance called chyme, consisting of partly digested protein, partly digested starches, and slightly digested fat. Chyme is discharged a little at a time through the pylorus into the small intestine. Food remains in the stomach from one to seven hours, according to the kind of food and the activity of the stomach. While the stomach is acting, its blood supply is increased, in order to equip the glands and muscles with what they need from the blood. One may get along without a stomach, for the intestinal juices can duplicate all the digestion of the stomach, but it is necessary to eat less food at a time since there is no reservoir to hold a large quantity. There is very little absorption of food from the stomach, although some sugars in solution, alcohol, and some drugs are absorbed.

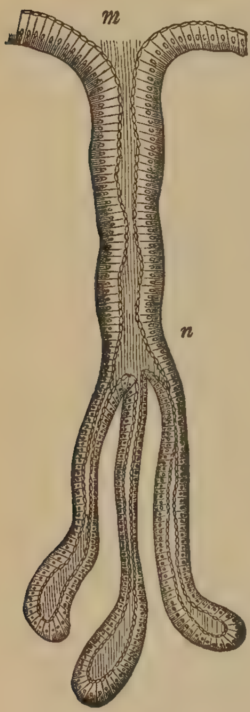


Fig. 105.—Pyloric gland of the stomach. (Bachmann and Bliss.)

The small intestine is a tube about twenty feet long and one to one and a quarter inches in diameter. Its first portion, reached by the pylorus, is called the duodenum. It is chemically the most active part. The next portion is the jejunum, and the lower portion the ileum. Throughout the small intestine are tubular glands that secrete the intestinal juice. Into the duodenum are poured also the bile from the liver and the pancreatic secretion from the pancreas. The food enters the small intestine as acid chyme. Because of the presence of bile it soon becomes alkaline. The enzymes produced by the glands in the intestinal wall are invertase, maltase and lactase, which turn complicated sugar molecules into simpler ones; and

erepsin which makes the partly digested proteins (peptones) into the final end-products, amino-acids. There is also produced in the small intestine a substance which activates the pancreatic secretion.

The further digestion of food that enters the small intestine would not be completed, however, by the product of intestinal glands alone. As has been mentioned, bile and pancreatic juice are necessary. The bile is produced by the liver, to the extent of about one pint in twenty-four hours.

FIG. 106.—Mucous membrane of the intestine, showing two villi with their blood vessels. (Lymphatics not shown.)

The liver is a large glandular organ in the right of the upper abdomen, which has other functions than the making of bile. The duct from the liver enters the duodenum but there is a branch that leads to the gall bladder, a small sac lying under the edge of the liver, where reserve bile is stored. When digestion is going on, bile enters the duodenum, but at other times it enters the gall bladder, whence it is given off during digestion.

Bile is partly an excretion, but it is still more a secretion of use in digestion. The body loses weight and strength even on a full diet if no bile gets into the duodenum, and digestive disturbances occur, largely due to the failure of fat to be

digested. Bile does not actually digest fat but prepares it for the action of the pancreatic enzymes. By its action on the fat in meat, it also permits the protein in meat to be better digested. It has to some degree also an antiseptic action, by limiting putrefaction of protein and depriving bacteria of the food they prefer. It also tends to stimulate motion of the intestinal muscle fibres. The flow of bile is stimulated by the presence of acid chyme and particularly of fat in the intestine. It is thought that it is stimulated also by hormones resulting from the absorption that has already taken place,

The pancreas produces what are perhaps the most important digestive juices. It is a solid glandular organ, about six inches long, shaped like a hatchet, and lying below and just behind the stomach. It has other functions than the production of digestive juices.

The pancreatic juice enters the duodenum by a duct in company with the bile. Its main enzymes are trypsin,

Fig. 107.—Diagram to show peristalsis. Note alternate constriction and dilatation.

amylase, and steapsin or lipase. Trypsin acts on peptones, carrying protein digestion to a further stage, in which it is aided by the intestinal juice. Amylase acts on starches which have escaped salivary digestion, turning them into maltose. Steapsin or lipase has its effect on fats, being practically the only enzyme that fully digests fat. Its action is favored by the presence of bile in the duodenum.

Almost as important as the secretions in the small intestine is its motility, which consists both of a circular constriction, first in one part of the canal and then in another, and a longitudinal contraction. The effect of the two motions combined is to move the chyme back and forth, but in the main to move it onward. The motion is not unlike that in the stomach. In each case it is called peristalsis. The purpose of the motion is that of mixing the food thoroughly with the secretions, and of leading it toward the large intestine, and while

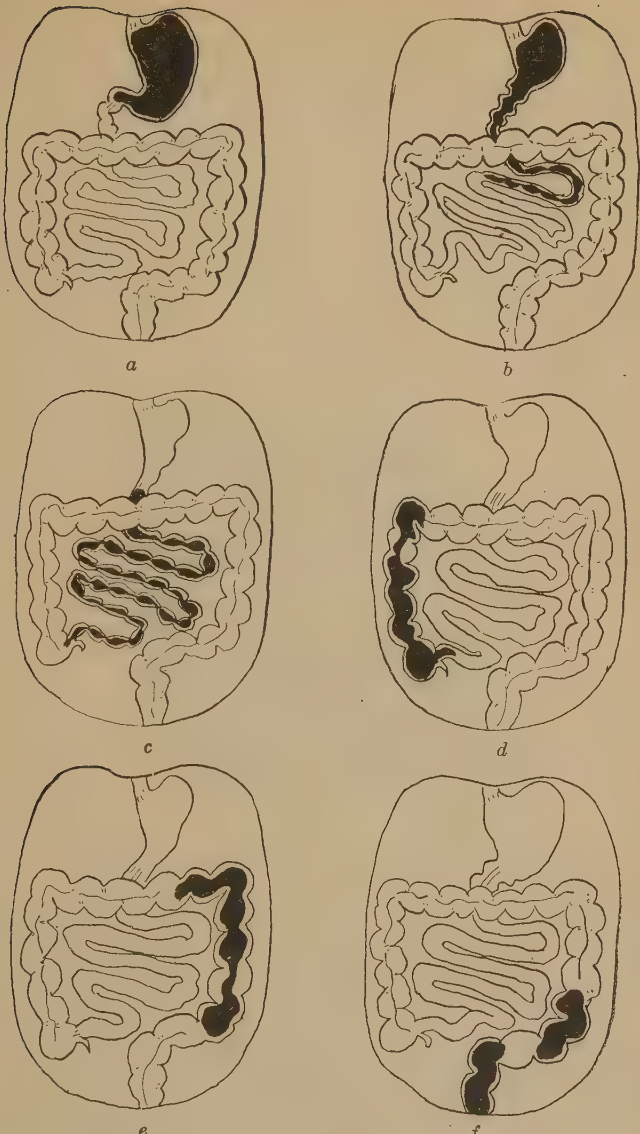


FIG. 108.—The progress of a single meal through the alimentary tract. *a.* stomach filled at 6 P. M. *b.* stomach partly empty at 9 P. M. *c.* stomach empty and small intestines filled at midnight. *d.* large intestine partly filled at 6 A. M. *e.* descending colon filled at noon. *f.* sigmoid and rectum filled at 6 P. M. (Note: variations in the rate of progress occur according to the character of the food and the activity of the tract.)

doing so to squeeze and press it against the walls of the intestine to favor absorption.

The stimulus to motion occurs because of the presence of food. Its rate is determined by several factors. Irritating qualities in the food cause more rapid peristalsis in order to get rid of the irritant. The rate is slowed or increased in various states of body or mind. Peristalsis may be quite inadequate if the muscle fibres lack tone, or if there is sagging of the intestine so that it is in a disadvantageous position. The rate of peristalsis may be studied by the fluoroscope or X-ray after a meal containing substances such as barium or

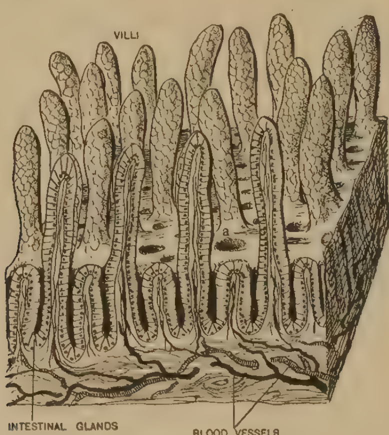


Fig. 109.—Villi and intestinal glands. (From Ritchie, "Human Physiology." Copyright 1908, 1915, 1920 by World Book Company, Yonkers-On-Hudson, New York.)

bismuth salts which cast a heavy shadow. Nutrition is better if the rate is sufficiently but not too rapid, for it is from the small intestine that almost all of the absorption of food takes place.

Absorption is made possible by the presence in the mucous membrane of cells that have as their intrinsic nature the ability to absorb properly digested food. The mucous membrane in the small intestine is not smooth, but has minute finger-like projections, less than $\frac{1}{25}$ inch high, that give it a velvety appearance. Each of these projections or villi is covered with columnar epithelial cells. Each villus contains both capil-

laries and a lacteal vessel. The latter is a special variety of lymphatic, and is for the purpose of absorbing fat, to be delivered to the thoracic duct. All other food substances are taken up by the blood vessels and carried to the liver by the portal vein. All food absorbed ultimately reaches the heart and the general circulation.

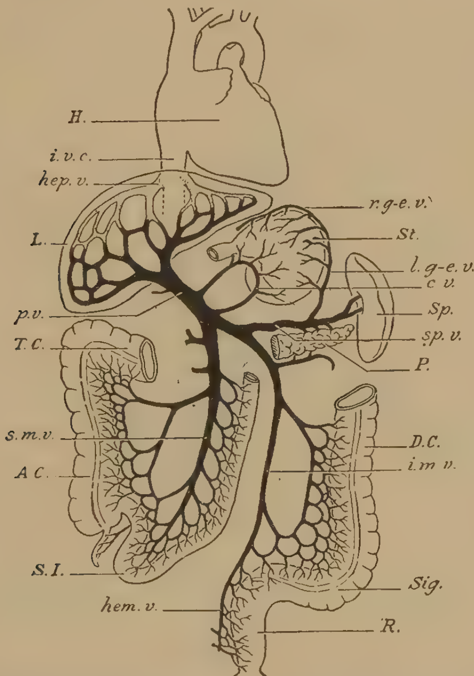


Fig. 110.—Diagram of the portal system. *H.*, heart; *L.* liver; *T.C.* transverse colon; *A.C.* ascending colon; *S.I.* small intestine; *St.* stomach (turned upward); *Sp.* spleen; *P.* pancreas; *D.C.* descending colon; *Sig.* sigmoid; *R.* rectum; *i.v.c.*, inferior vena cava; *hep.v.*, hepatic (liver) veins; *p.v.*, portal vein; *s.m.v.* superior mesenteric vein; *r.g-e.v.*, *l.g-e.v.*, *e.v.*, veins from the stomach; *sp.v.*, splenic vein; *i.m.v.*, inferior mesenteric vein; *hem.v.* veins from the rectum. (Bachmann and Bliss.)

The process of absorption begins in the duodenum, but the greater part of it takes place farther on, after the foods have been more fully digested. Some few foods are ready for absorption as they are taken, and, as has been seen, some slight absorption takes place from the stomach.

Water, some fruit-sugars, pure honey and alcohol need no digestion. Most of the food needs the action of the salivary and gastric juices, and especially of the intestinal and pancreatic juices and bile. As the food progresses through the intestines, proteins have been acted upon by pepsin, trypsin, and erepsin; starches by ptyalin and amylase; sugars by maltase, invertase and lactase; fats by lipase and bile.

Carbohydrates are absorbed after they have become dextrose; proteins after they have become amino-acids or

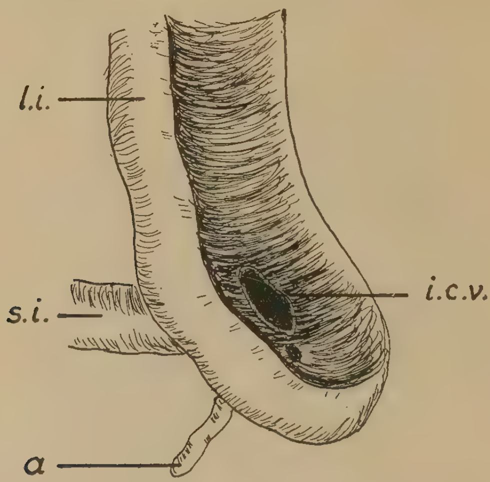


Fig. 111.—The caecum and the vermiform appendix. *l.i.* large intestine; *s.i.* small intestine; *a.* appendix; *i.c.v.* ileo-caecal valve.

other very simple nitrogenous substances; fats after they have become soap and glycerol and fatty acids. The materials taken into the cells of the villi are at once passed out to the blood or lymph vessels, although in the case of fat, its end products are made again into fat within the cell body before being discharged into the lacteal.

At its lower end the small intestine is joined to the large intestine or colon, a tube about four to six feet long and 1½ to 2½ inches in diameter. There is a blind pouch, called the caecum, produced by the joining of the small intestine to the large one at an angle. At this point is given off the appendix,

a small blind tube with the very limited function of producing a small amount of mucus. Both of these structures afford unfortunate lodgment for intestinal contents, if there is any delay in progress there. The caecum usually empties in time, but the appendix often retains waste and bacteria long enough to become the seat of inflammation (appendicitis).

The origin of the colon is rather low in the right side of the abdomen, whence it rises, crosses the body and descends on the left. Near the hip bone on the left is an S-shaped curve called the sigmoid flexure which also is a common location for accumulation and delay of the intestinal waste. From there down the large intestine is called the rectum, which opens into the next portion, the anus.

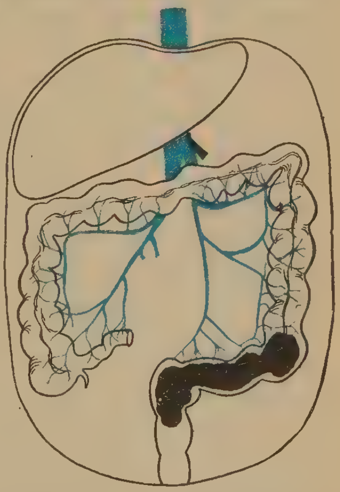


Fig. 112.—The colon; showing the lymphatics for absorption chiefly of fats.

Between the small intestine and the large is the ileo-caecal valve which opens occasionally to permit the passage of food to the colon. At the anus there are two sphincters, one of which is under voluntary control. Their function is to act as valves, to delay until appropriate times the escape of intestinal contents.

The material coming from the small intestine passes slowly through the colon, and is still acted on to some extent by the enzymes that are brought along mixed with the food. During the twelve hours the food remains in the colon, therefore, a small amount of digestion is carried on, although the colon itself produces no digestive enzymes.

There also remains a little absorption to be done by the colon, chiefly of water. During its stay in the small intestine the food has decreased in bulk to a considerable degree. In the large intestine it decreases still more, and changes from a fluid mass to a semi-solid one. There are many bacteria as normal inhabitants of the large intestine. Some kinds produce

changes in the contents of the colon that are beneficial (those that cause fermentation with lactic acid formation); others are most injurious (those that cause putrefaction).

The peristalsis in the colon is less active than that in the small intestine, although it is sufficient to keep the contents moving back and forth, and eventually outward. The impulse toward defecation (discharging of excreta) is due to peristaltic waves in the sigmoid, which cause material to collect in the rectum and to arouse the sphincter to open. Ordinarily it takes about twenty-four hours from the ingestion of food to its final discharge—twelve hours in the stomach and small intestine and twelve hours in the colon. The feces consist of undigested and indigestible remnants of food, remains of digestive juices, bacteria, and a varying amount of water.

Although what happens to food after absorption is not the work of the alimentary tract, it is for these later purposes that the alimentary tract exists. It has been mentioned that the absorbed food goes to the liver first (except the fat, which goes directly into the thoracic duct and into the circulation). In the liver dextrose, that results from carbohydrate digestion, is taken out of the blood and stored in the liver as glycogen.

The rest of the food then circulates about through the body, first of all to supply the cells with the materials they need. The needs of the cells are of several sorts. The first is for repair of their structure. There is daily loss of the substance of the cells of the body, which must be made good by the food taken in. In the growing period there is necessary also the material that will cause the substance of the cells to increase. The second need of cells is for material with which to produce secretions. The third need is for material that shall be a source of energy in cell activity, and of bodily heat, which is incidental energy. The first two needs are largely met by protein. The third is met by carbohydrate and fat chiefly, but also by protein.

Since the body cells are largely protein (protoplasm) and their secretions largely protein, it is clear why the growth and replacement and secretory needs are to be met by protein food. No other than nitrogenous food will satisfy these demands. Body protein is derived from the amino-acids which result

from the digestion of protein food. As they circulate in the blood each cell takes what it needs. After all cell needs are met the remaining amino-acids are broken up in the liver, the nitrogen being excreted as urea by the kidneys, and the carbon, hydrogen and oxygen being combined to make carbohydrate, which thereafter is used as any other carbohydrate. There is a very well-balanced nitrogen metabolism in the body.

The energy needs of the body are met by oxidizable substances which have been digested and absorbed. In the cells these substances break up their loose chemical bonds readily, and liberate energy of many kinds. The chemical end-products of oxidation, carbon dioxide and water, are excreted. The conversion of food into energy in the body may be likened to the furnishing of motive power to an automobile by the gasoline. The varieties of energy produced in the body may be likened to the varieties produced in an automobile—starter, lights, horn, heater as well as motion all being directly or indirectly due to the power generated in the engine by the combustion of fuel.

The fuel or energy value of food is measured by estimating the amount of heat it produces when burned. The unit of heat is the calorie (small calorie = the amount of heat necessary to raise one gram of water 1° C.; large calorie = amount needed to raise 1 kilogram of water 1° C.). The caloric or energy value of carbohydrate and protein is approximately the same, and of fats about twice as much.

Carbohydrate and fat are, then, the chief fuel foods. They are alike in some respects: both are composed of carbon, hydrogen and oxygen; both yield much energy; both produce body heat; both give off carbon dioxide and water as end-products; finally, both are stored in the body to provide for energy needs that are not immediate. Carbohydrate is stored in the liver. Fat is stored in adipose tissue. If an excess of carbohydrate is taken in, it is also stored as fat in adipose tissue, most fat tissue being of carbohydrate origin.

The storage of carbohydrate is so important that all food goes to the liver first, that the liver may get carbohydrate. The liver stores it as glycogen, but on demand from the muscles releases it as dextrose. Because the muscles are always acting

to some degree, they must always have some glycogen in them. The muscles may also be considered a carbohydrate storage place, as well as the chief place where it is utilised. Because the liver is constantly giving off some carbohydrate, a very small amount will always be found in the blood.

The advantage of glycogen storage is the same as that of a full coal-bin, or a full gasoline tank. The advantage of fat storage, up to a certain amount, is much the same. If the body cannot get or cannot absorb food for a time, it may finally consume its own fat as fuel. In starvation after the carbohydrate stores are used the fat is used, then the protein substance of the body. Excess storage of fat, however, is hampering to the body functions.

The metabolism of carbohydrates is affected very much by the action of the internal secretion of the pancreas. The larger portion of the pancreas produces the pancreatic juice, but scattered through it are clumps of another sort of glandular epithelium called islands (or islets) of Langerhans. These produce insulin (or iletin), which controls the ability of the body to deal with carbohydrate food. If insulin is not present in sufficient amount, glycogen storage and use are interfered with. The carbohydrate food cannot even be stored as fat. It can only be gotten rid of through the kidney as fast as possible. Meanwhile the metabolism of fat, and even of protein is likely also to be deranged. The disease diabetes, in which this occurs, is now controllable not only by the regulation of the diet, as was formerly the sole and unsatisfactory method, but also by the giving of the extract of the pancreas, insulin, obtained from animals.

There are other food substances taken in the diet that meet special structural and functional needs of the body, but they do not require digestion. They are mineral salts, vitamins, and water. They are absorbed along with the other end-products of digestion. After absorption, although they take part chemically in the repair and nutrition of cells and in the making of secretions, they are not oxidized and thus yield no direct energy. Indirectly, by making the body better able to work, they increase the ability to use energy. It would not be possible to live very long without minerals or vitamins,

and death follows within a week or two if no water is taken. Animals die sooner on a diet without salt than without any food.

The function of the alimentary system may be summed up as the changing of food into products which can be absorbed, the absorption of these products through its villi, and the discarding of its waste. The process of nutrition of the body is a matter that is conducted by the cells of the whole body.

CHAPTER XIV

THE EXCRETORY SYSTEM

Much waste is produced in the body as the end-product of metabolism. After the substances eaten have passed through the digestive tract to the circulatory system and have gone in and out from the cells, they are quite changed in chemical composition, and some of them are no longer of use to the body. Some of them have been used up in making tissue, energy, and secretions, and in producing body heat; but there is some waste left from food products, analogous to the ashes left after a fire. There is also some waste of the very substance of the body cells themselves.

To get rid of this waste, there are several organs that have as a part of their function elimination, although they have other functions. The lungs are for the purpose both of taking in oxygen and giving off the gaseous waste, carbon dioxide. The skin's products are secretions, of use to the body, rather than excretions of waste. The sebum is of use on the skin, and the perspiration is for temperature regulation. It is merely by chance that the perspiration ever contains any of the body waste. Never does it relieve the true excretory organs of their function—except in the case of damaged kidneys, when the skin if active may help in getting rid of more water.

The liver is sometimes included under the excretory organs, in that its bile is given off by the intestine when its work in digestion is over. The liver is far more important not as an excretory organ itself, but in preparing material for excretion by the kidney.

The intestine is sometimes considered among the excretory organs, and it is true that excreta in solid form do pass out of the intestine, but the intestine merely allows waste that has accumulated in it to pass out. It is not a chemical or vital

process of excretion of materials carried by the blood as other excretions are, but a process of elimination.

The intestinal waste consists of remains of food such as was not digested or could not be digested; remains of bile; remains of intestinal secretions; worn out epithelial cells; many bacteria (one-fifth or more of fecal weight), such as live, reproduce and die in the intestine all the time; the products of decomposition of food by bacteria; and water.

The kidney is the only organ purely for excretion. The body must have at least one working kidney or it dies. The work of the kidney is prepared for by that of the liver.

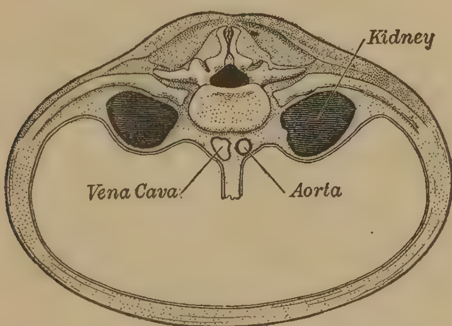


Fig. 113.—Diagram of cross section of abdominal cavity, showing kidneys. The intestines have been removed; in the median line is the cut border of the mesentery. (From Hough & Sedgwick, "The Human Mechanism." Courtesy of Ginn & Co., Publishers.)

The waste material from the body cells is turned out into the blood stream, just as are the various products of the cells that are of value. The wastes circulate about until they reach finally an excretory organ. The carbon dioxide is taken out of the blood by the lungs primarily; and other substances by the liver and the kidney. Those that go to the kidney directly are the non-nitrogenous materials and water; those that eventually reach the kidney after preliminary preparation are the nitrogenous substances.

The nitrogenous waste is acted upon in particular by the liver. Certain of its cells have this function, of making nitrogenous waste into a substance called urea. The urea then leaves the liver and goes back into the blood stream, and

finally travels to the kidney. There is always much blood in the liver, bringing nitrogenous waste that is changed into urea. Urea is probably formed to some extent by all body cells, although in much less quantity than by the liver, whose location in respect to the portal circulation gives it unusually

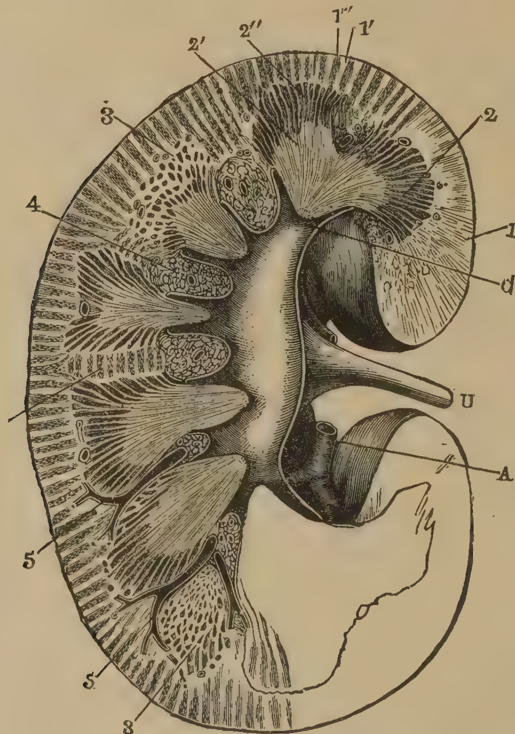


FIG. 114.—Longitudinal section of the kidney. (Bachmann and Bliss.)

free access to blood containing excess nitrogenous compounds. Finally, the urea is excreted in the urine by the kidney. The kidneys consist of a pair of organs situated close to the floating ribs in the lumbar region, or about at the waist line. They are oval or bean shaped, about 4 or 5 inches long and 1½ inches wide. In color, they are very dark red because of their large blood supply.

They are practically stationary, being the only abdominal organs that are so. They are situated behind the peritoneum and are held in place partly by the close contact with other organs, partly by the blood vessels and nerves that enter them and act as supports, partly by the mass of fatty tissue that surrounds them, and partly by the connection between their connective tissue capsule and the lumbar muscles and aorta.

At the side of the kidney that is nearer the median line of the body is a depression called the hilum. It is here that the vessels and ducts and nerves enter and leave.

Inside, there is an open space called the pelvis of the kidney. The outermost layer of the kidney is called the cortex. Below this is a layer of tissue which has projections into the pelvis called the pyramids.

In the cortex is the epithelium that gives the kidney its function. This is arranged as convoluted tubules of great complexity, arranged always so as to have a full blood supply near the wall of each tube. As the blood goes near the tubes, material gets into the blood in two ways. First, it enters the tubes by mechanically oozing through into them. Second, it enters them because of the active selective action of some of the tube epithelium. It is believed that water and salts pass through in the first way, and that nitrogenous waste and other substances pass through in the second way.

The secreting epithelium has underneath its single layer of epithelial cells a little supporting tissue, which holds the blood vessels and nerves that are so essential for secretory activity. The nerves are those that change the calibre of the blood vessels. Probably there are not any directly secretory nerves as there are to the sweat glands. Kidney secretion would thus be dependent on the amount of blood supplied, that being dependent on the dilation or contraction of the capillaries. As everywhere in the body, there are lymphatic spaces. The vasomotor nerves are like all vasomotor nerves in being activated by the autonomic system.

The convoluted tubules finally straighten out and pass down through the pyramids and empty into the pelvis of the kidney as collecting tubules, carrying urine.

From the pelvis of each kidney, there is a tube about twelve inches long that runs down through the body to the bladder, which is in the pelvis. Urine is always passing through to the bladder.

The bladder is a reservoir for the urine. It holds a pint or more when full. It is of unstriped or involuntary muscle, lined with mucous membrane. The mucous membrane is in folds when the bladder is empty, so as to permit of its stretching when full. The muscles run in all directions, so that when they contract the bladder gets smaller in all dimensions. The contraction of the bladder is to expel the urine in a process called micturition or urination.

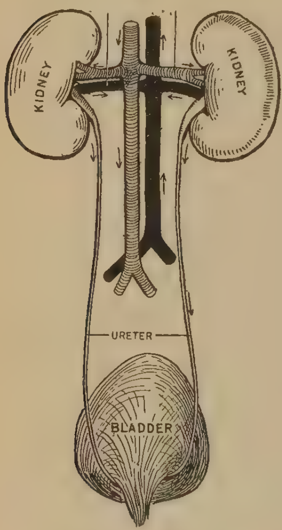


Fig. 115.—The kidneys and the bladder. (From Ritchie, "Human Physiology." Copyright 1908, 1915, 1920 by World Book Company, Yonkers-On-Hudson, New York.)

The opening of the bladder outward is into the urethra, a tube seven to eight inches long in the male and only about one and one-half inches long in the female. At the opening of the bladder is a ring of muscle called, as such muscle rings guarding openings are, a sphincter. This is ordinarily kept contracted so that urine does not pass out involuntarily. When the bladder becomes full enough, a sense of this fullness passes to the cerebral centers and down the cord to the center for the control of this sphincter. It may then be voluntarily relaxed and the bladder contracted. This usually happens five or six times a day, but usually not during the night. Other causes than its actual distention may lead to a feeling of necessity to empty the bladder. The center in the cord is subject to reflex stimulation. The sphincter has to be trained in children, or the fullness of the bladder opens it involuntarily. It is possible to prevent the bladder from emptying until it is enormously dilated. It is very distensible, and seldom ruptures.

The urine, as has been mentioned, is a product of the activity of the cells of the kidney, not like any other fluid of the body or any other known fluid. Its chief constituent is water.

Examination of the urine is done in order to determine what the end-products of body chemistry are, and thereby to learn something of the body chemical processes themselves. Nitrogen metabolism in particular may be well studied in this way. If a larger amount of nitrogenous matter appears in the urine than is usual, the cause of it must be found. Through the study of many normal individuals, it is possible to learn about what should appear in the urine. There is not much variation in health on an average diet. The form in which nitrogenous waste appears in the urine indicates something of its source. The chief form in health is urea. Uric acid is also a normal constitutent of the urine. Albumen is generally abnormal. It is found when tissue waste is excessive, as in fevers and in some diseases or malfunction of the kidney itself.

Aside from water and nitrogenous waste, urine contains mineral salts which represent what is found in food that the body has not used, and to some degree the breakdown of tissue itself.

In studying the urine, it is important to have the whole twenty-four hour quantity because metabolism changes during the day and different chemicals will be found at one time than at another. It is also desirable to have that which is passed at night and that passed by day, for it often varies greatly according to the posture. In some persons, the kidney functions less well while the individual is up and about, perhaps because the kidney circulation is interfered with by poor posture. This may usually be corrected by providing the kidney with as good blood supply while standing as while lying, by improving the posture.

Increase of urine above the usual three pints a day is due, first, to the increase of the blood supply to the kidney, such as results from increasing the activity of the circulation generally, as in exercise. It will also be increased under any circumstances that induce greater metabolism of tissues. It increases when more fluid is taken, or when the vasomotors are stimulated by excitement. Especially is it increased upon exposure

to cold. Blood is driven out of the skin by the contracting capillaries, and takes its place in the interior of the body. The kidney has its share of the interior increased supply and secretes more urine. When the urine is increased for this cause, there will be less perspiration.

Urine is decreased when perspiration has been going on vigorously, inner parts of the body thus having less blood supply while the skin has more. Since the skin has more, it eliminates more of the fluid that is to be eliminated. In fever, the urine quantity is usually decreased, but the solids in it are increased, giving a concentrated, highly colored urine. This is the most difficult situation in which the kidney finds itself, being obliged to get rid of a large amount of waste in a small amount of fluid. A similar situation may be produced by too low water intake.

CHAPTER XV

TEMPERATURE REGULATION

The mechanism for the regulation of temperature offers one of the best examples in the body of coordinated action. Many functions take part in it. The chief role is played, however, by the skin.

Man has a constant temperature of about 98.6° F. At this temperature the body cells work best. Without a means of keeping at about this temperature man could live only a short time. Poikilothermic animals take a temperature approximating that of the surrounding air. They are called "cold-blooded," but they are not cold if the air is not cold. Birds and mammals, however, which are homoiothermic, do not take the temperature of the medium in which they live, unless the regulation of temperature within them proves inadequate, or the odds are much against it.

The technique of heat regulation is not perfect at birth, but must be acquired. The infant is more like the poikilothermic animals. In old age there is a tendency for the body to lose the ability to maintain stable temperature. In some there is never very satisfactory balance between heat loss and heat production. In all individuals there is greater variation of temperature in illness than in health. Body temperature is never maintained at an absolutely uniform level. There always occur slight variations at different times of the day, the early morning temperature being slightly lower than that of the late afternoon.

When the term body temperature is used, it means the temperature of the interior of the body, which may be determined by the use of a thermometer in the mouth. The impression of being warm or cold is not due to changes in internal body temperature but to the stimulus of the sensory nerves in the skin. It is possible to feel chilly because the skin

is cold, and at the same time to have a fever. The skin, mouth, pharynx and oesophagus are the only parts of the body that have temperature end organs that can feel heat and cold adequately. To one's self or to another observer the skin may feel hot even though the body temperature is not raised.

The body is like a house with a heating apparatus regulated by a thermostat. In the body the thermostat is located in the thermotaxic and thermogenic centers in the brain. Conditions in and around the body send sensory impressions to those centers, and outgoing impulses are sent to various parts of the body to raise or lower the body temperature.

FIG. 116.—Cross section of skin, showing sweat glands. (Semi diagrammatic). (From Potter, "Compend of Anatomy.")

Since external temperature is one of the most important factors in making temperature regulation necessary, its effects should be particularly noted.

Heat or cold outside the body tends to raise or lower body temperature as in the poikilothermic animals; but in the higher animals and man the body adapts to it and remains at its usual temperature. The application of either heat or cold on the body has an effect on the capillaries, either increasing or decreasing the amount of blood in them. This is brought about by the sensation of either heat or cold on the skin, which sensation is carried to the vasomotor center and there sets up impulses to produce, in the case of heat, dilatation of the capillaries; and in the case of cold, contraction of the capillaries. The former brings the blood to the surface to be cooled. The latter sends the blood away from the surface to prevent its undue cooling.

The same sensations of heat or cold also set up in the centers that govern secretion of the sweat glands, impulses either to secrete more or less—heat producing more secretion, and cold, less.

At the same time the hot or cold sensations are sent to other parts of the brain and cord and produce stimuli either to increase heat production or to inhibit it.

There is also another effect produced by sensations of heat or cold—that of stimulating or inhibiting muscular contractions. The state of tone of the muscles (their partial contraction) is definitely less on a very hot day, giving a limp feeling that is due to really limp muscles. The "bracing" effect of cold is just the opposite. It gives a quite perceptible increase of muscle tone. More heat is produced by even this small amount of increased contraction, and, conversely, less is produced by their relaxation. The individual with habitually poor muscle tone "feels the cold" much more than one with a healthy muscle system. Finally, sensations of heat or cold affect the respiratory center, so that breathing is made either faster or slower, to give off more or less heat. As has been mentioned, there are temperature regulating centers in the brain, but the mechanism by which it is accomplished is distributed throughout the body, and the process is accomplished in all of the ways mentioned.

It is not only external sensations of heat or cold, carried by affector nerves, that accomplish these results, but sensations from the interior of the body, similarly carried to the centers. Furthermore, when the blood is sufficiently heated, as it flows through the centers mentioned, it arouses nerve impulses in various parts of the body both to lessen heat production and to increase heat loss. The reverse is true if blood that is too cool passes through the centers. Whether nerve sensations or blood temperature arouse the centers, nerve impulses travel out to the various parts of the body involved to perform the function of restoring the deranged temperature to normal.

Aside from the adjustment to the external application of heat, it must be borne in mind that the body must adjust to the heat it produces itself. Heat production occurs wherever metabolism takes place, more heat being produced in the more

active organs—especially in the muscles. The cells of the liver and of the organs of digestion also carry on rapid oxidation. Activity of any of these active cells of the body leads to more heat production, as for example, during and after the digestion of a meal, and after muscle exertion. Even the brain generates a little heat when it works.

Four-fifths of the output of bodily energy is concerned with heat production. Eighty per cent of the food eaten is consumed in the cells to make heat. Approximately 2000 to 3000 calories of heat are generated in an adult body a day by the activity of all its cells. First, the amount of heat is to some extent, in proportion to the food eaten, although the rate of metabolism is affected by cellular activity, particularly that of muscle cells. It is also influenced by the activity of the thyroid and adrenal glands. These factors help to determine the amount of heat produced, and thereby influence the body temperature level. The kind of food also makes some difference. Although carbohydrates and fats are the fuel foods, protein food has a direct effect in raising temperature. Second, some small amount of the increase in heat comes about not as a result of chemical processes but by friction, as of the muscles in exercise, or even of the blood as it flows against the walls of the vessels. Third, a very small amount of increase of body heat is due to the ingestion of hot foods and liquids.

The application of heat to the body from the outside is potentially one of the sources of increased body heat, as has been mentioned. The blood at the surface is warmed and carries the heat all through the body; furthermore, the heat on the surface penetrates by conduction directly through the tissues.

If the heat that the body acquires and produces beyond its demands could not be readily eliminated, a rise in temperature inconsistent with life would soon occur. The aim in temperature regulation is to maintain a constant temperature level throughout the body which provides for the adequate maintenance of body function. The regulation of temperature is one of the most arduous tasks of the body. The digestive tract, even, is allowed to get along with a very restricted blood

supply, if it is necessary to send a good deal of blood to the surface of the body for cooling.

Heat loss from the body is brought about largely by the cooling of the blood at the surface. There are several ways in which heat loss is possible through the skin. First, heat may be lost by radiation. A man in an ice-lined chamber causes ice to melt because of the radiation of heat away from the body. The fact that exercise and digestion increase heat production is shown by the fact that more ice is melted if the man walks about; still more is this so after a meal. Radiation means the departure of heat through space. The sun is the best illustration of radiation. Although it is millions of miles away, its heat reaches the earth, at times with great intensity. An open fire or a stove, or a human body, is also radiant. It is not necessary for an object to glow in order to radiate heat.

The second means by which heat is lost from the body is that of conduction. If the man in the ice-lined chamber were to lean against the ice wall, it would melt more rapidly at that spot, because the heat of his body would be conducted to the ice. Conduction is the passage of heat from a warmer object to a cooler one with which it is in contact. The temperature of the warmer object is lowered to the same extent that the cooler one is raised. In getting into a cool bed or a cool bath, or on exposing the body to cool air, a considerable amount of body heat is conducted to these media. Water conducts heat away more rapidly than air. Water at the same temperature as air feels cooler against the skin for that reason.

The third way in which heat is lost from the skin is by convection, which means that the heat is blown away by currents of air. Convection acts when there is a breeze blowing or the body creates its own breeze by moving about. Even rocking in a chair creates some breeze. The effect of convection is to remove the blanket of warm, moist air that accumulates next the body. If this air stays about the body, the body heat is less readily regulated.

The rate of the breeze determines its effectiveness. When the body is warm, cold air at a low rate is perceived more readily than warm air at the same rate. If the temperature of

the body and the air are nearly the same, the rate of motion must be quite rapid in order to have the breeze perceived at all. It is difficult to create a satisfactory breeze on a very hot day. Convection is sometimes interfered with by too heavy clothing. It should be noted that warm air tends to rise, even without a breeze, and that at ordinary temperatures a limited amount of heat loss from the body may be counted on.

The three methods of heat loss just mentioned are known as heat transfer. There is a fourth method of getting rid of

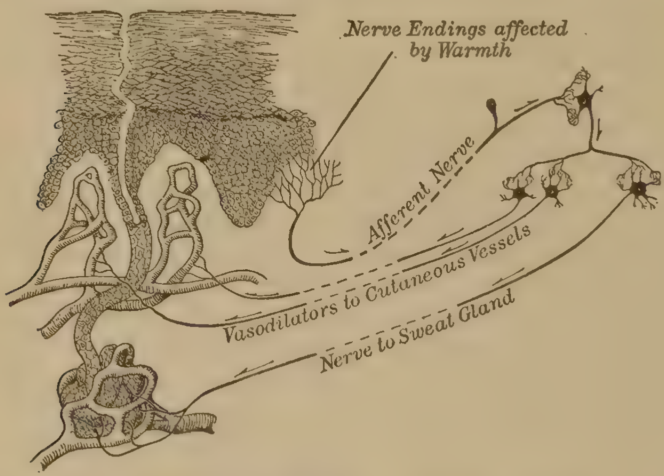


FIG. 117.—Diagram of the cutaneous reflexes for temperature regulation. Showing the epidermis, blood vessels of the dermis, a sweat gland, and the nervous mechanism governing blood vessels and sweat glands. Note one afferent and two efferent pathways. (From Hough & Sedgwick, "The Human Mechanism." Courtesy of Ginn & Co., Publishers.)

heat from the body—that of evaporation. It is more important than any of the others, for the others are not sufficient to cool the body if evaporation stops. Evaporation takes place to a small extent in man from the lungs. In some animals, notably dogs, much heat is lost through the vaporizing of water in the expired air. The panting of the dog on a hot day is for this purpose. Most of the evaporation from man takes place from the skin. It is the largest single source of heat loss. The method has been described in detail in the discussion of the skin function.

The necessity for heat loss is normally met by an increase of blood in the skin. Ninety per cent of heat loss takes place thus. The warm blood that comes to the skin loses its heat in the four ways mentioned. The necessity for heat loss may be due to an increased heat production within the body or to increased external temperature, but in either case the result is the same—there is more blood found in the skin. Whenever this is the case, heat is lost by the four means mentioned. Conversely, heat loss is diminished by whatever takes blood away from the skin.

The individual who looks flushed on a warm day or after exercise, especially if perspiring, ought to, and probably does, if it could be determined, feel cooler than the one who at the same temperature and under the same amount of exercise looks pale and does not perspire. At all events, he is getting rid of more heat. Both high temperature and exercise, since they tend to raise temperature, demand a considerable heat loss. Both bring out temperature adjustments, if the regulating mechanism is normal, that result in the body temperature not becoming actually higher, however hot one feels.

There are several causes for increased blood in the skin that do not imply any aim of the body to lose heat. One of these is the drinking of alcohol, which dilates the surface capillaries. Heat is then lost from the body largely by radiation. The body feels warm because there is more blood where the temperature end organs are. Its actual temperature is lowered. Radiation after drinking alcohol leads to the possibility of chilling because of the actually lower interior temperature and the misleading sense of warmth in the skin. Whenever the surface vessels have been dilated for any reason, chilling may follow the undue cooling of the interior, and too great subsequent transfer and evaporation.

Evaporation usually takes place in response to demands for heat loss, the intervening step being dilatation of the capillaries by the vasomotor nerves. It will be recalled, however, that the secreting sweat glands have nerves of their own and that they may be separately stimulated—in emotion and shock, for example—when there is no demand for perspiration to cool the body by evaporation. This increased secretory activity is

very likely to come on when the body is weak, as after a fever, at which time it leads to a cooling of the body which was not called for, and is unsafe. It should be borne in mind that perspiration from whatever cause leads to the same result—evaporation and loss of body heat.

The distribution of blood from warm parts of the body to cool ones produces little general cooling except when the blood goes to the skin. The skin is always the coolest part, because it is in contact with the air. It presents, moreover, a very large surface, capable of exposing to its environment a very large amount of blood.

Loss by conduction is accomplished to some degree by the taking into the body of cold food and drink. The food reaches body temperature, but the body temperature falls a little by contact with the cooler substances. A similar small degree of heat goes on through the conduction of the heat to the air breathed in; the air that is breathed out is at body temperature, and the blood has been slightly cooled in warming it.

The principles involved in heat gain or loss may be deliberately applied for the purpose of either increasing or decreasing body temperature. Retention of body heat on exposure to outside cold is by means of checking heat loss. There is some difference between individuals in the effect of exposure to external cold, depending on the thickness of the fat layer under the skin, which is a non-conductor of heat, and on the rapidity of metabolism. Some have little difficulty in keeping warm and some have little difficulty in keeping cool.

When the external temperature drops below 65° F., the tone of the muscles begins to increase and the skin becomes paler. At 60° F. the arterioles have contracted about as much as they can. From that temperature down, compensation for lowering of external temperature must be met by increase of heat production or the retention by more clothing of that already produced. Usually room temperature should not be allowed to go below 60° F. unless special efforts are made to combat the lower temperature. Increased heat production, when the temperature is below 60° F., is made easier by the fact that when the surface capillaries contract, those in the interior dilate and can supply the muscles and active organs with more

blood. The appetite and the digestion are often better in cooler weather.

Under some circumstances the interior of the body may not take advantage of the increased blood supply, and the blood may fail to locate itself in working muscles, but may congest the delicate membranes, especially of the respiratory tract, and cause harm. Such trouble is less likely to arise in an individual who uses the muscles freely.

The optimum temperature to have about one's body is from 65 to 70° F. There are three danger points—high extremes, low extremes, and just below the optimum. The reason the latter is dangerous is that the cold stimulus is not very pronounced, and the response, therefore, is often inadequate.

The moisture content of air is as important as its temperature in its effect on heat regulation of the body. Moisture favors conduction but interferes somewhat with radiation and evaporation. Moist air conducts heat away from the body more rapidly than dry air at the same temperature. On this principle a cold damp day would seem colder than a cold dry one. On the other hand, when the temperature is high, a moist day does not seem cooler than a dry one, but quite the reverse. This is because at the higher temperature evaporation is the important source of heat loss. Hence, a hot moist day seems still hotter because little evaporation can take place, the air already containing about all the moisture it can hold. Radiation also is less when the air is moist. Heat strokes are more likely in moderately hot, moist weather than in much hotter, drier weather. It is on such days that the body needs to be aided in keeping cool. The same is true regarding cold moist weather, which makes special efforts necessary to avoid too great heat loss. Under any ordinary temperature changes in either direction, either within or without the body, the likelihood is that the body in health will succeed in adapting, if a little attention is given to making the task not too heavy.

If the increase of body temperature is not compensated for, the thermometer registers a rise above 98.6° F., and the condition is called fever. It is due either to increased heat pro-

duction or to diminished heat loss. The temperature may rise very high on extreme exposure to the heat, giving heat stroke or sun stroke. Other causes of fever are; action on the heat centers by the toxins of bacteria in infection, the retention of body waste, or poisoning or injury of tissue by mechanical, thermal or chemical agents. After a severe accident or an extensive burn either by heat or chemicals, the temperature may rise because of poisons carried through the body from the injured tissue.

A person with fever is likely at the first to feel chilly. This is because the skin capillaries are at first contracted. Metabolism has increased, producing more heat. The body wastes away if this condition is long continued. It could be demonstrated in a laboratory that more oxygen is used and more carbon dioxide is given off. At such a time muscle exercise increases the fever, although in health the increased heat production from muscle exercise is compensated for without giving rise of temperature. If the urine were examined, it would show substances indicating tissue waste to be increased.

Accompanying fever there are the usual efforts of the body to get rid of heat. In order to accomplish this the skin becomes much congested and usually feels hot to the touch. Respiration increases its rate, and the heart beats faster. Secretion throughout the body is generally impaired, which gives some of the characteristic symptoms, such as parched mouth, loss of appetite and poor digestive ability.

It is probable that fever is a protective reaction and that the toxins responsible for it are better gotten rid of by the temporary rise of temperature than they would be without it. But fever itself represents a danger if it is very high, in that there may be coagulation of body proteins and other perhaps fatal effects. If it is less high, it may still be dangerous because of excessive wasting of the body. Generally, high temperature is of less significance in children than in adults. Even in early adult life in some individuals it may have little significance. When fever has served its purpose, it ceases either suddenly by crisis or gradually by lysis.

After fever there is likely to be some instability of temperature for some days or perhaps longer. There will be likely to

be an increased tendency to sweating, and in fatigue an easy rise of temperature. Subnormal temperature is also likely. Aside from its occurrence after fever, subnormal temperature is found chiefly in those whose temperature regulation is poor because of debility. It appears in them chiefly in the morning or on exposure to cold. It occurs in starvation or the semi-starvation associated with "dieting." There are some persons whose metabolic rate is naturally low, who have subnormal temperature habitually. Generally speaking, the temperature itself, whether high or low, is not so much a matter of concern as is the cause of its variation.

CHAPTER XVI

THE REPRODUCTIVE SYSTEM

In the unicellular organism reproduction is simple, consisting of a mere division of the cell into two equal parts, the nucleus dividing into two parts so that an equal amount of the inheritance material goes to each of the two offspring. Such offspring are, except for external causes, exactly like the parent.

The process becomes more complicated in the higher forms of life. In them there are certain cells set apart to carry on reproduction. In either case, however, the process consists of a separation of a part of the living organism to form new separate individuals that have a life of their own, inheriting the same qualities the parent inherited—both offspring and parent being the product of a long line of ancestors. Among humans the child is not exactly like the parent because he inherits, as his parents did, a little here and there from many ancestors.

In the single-celled animal the whole cell goes on living in its two offspring. In higher animals and man, only the reproductive cells go on living, and the rest of the material animal dies.

In the higher animals, before the life of the reproductive cells can take the form of another animal of the species, the sex cells of the female must unite with the sex cells of the male.

The highest group of animals are known as mammalia, the offspring being nourished in the mother's body for some time after it has been formed, and being thereafter usually nursed at the breast during infancy.

The reproductive system consists of the organs in which the reproductive cells are contained (called gonads), and other organs to favor the union of the male and female cells. In the female there is also an organ in which the embryo develops. These organs are contained in both sexes in the pelvis, and in

the male partly on the exterior of the body. They are present before birth, but do not attain full development or ability to function until a time called puberty, which comes from eleven to sixteen years of age in the female and slightly later in the male. The age at which it appears depends upon the activity of certain of the endocrine glands. The duration of the functioning sex life is until forty-five to fifty years of age in women, and usually until old age in men.

At puberty not only the sex glands themselves develop, but other characteristics that distinguish male from female. In the male the voice deepens, hair appears on the face and body, and the body becomes more angular. In the female the pelvis widens, the subcutaneous fat becomes more marked, especially about the breasts and hips, hair appears about the external genitals and under the arms. In the male seminal fluid may be passed, in which the sex cells are contained; and in the female menstruation appears. In both sexes there tends to be an attraction to the opposite sex, which may be merely on the plane of companionship, or may be of the nature of intellectual interest or sex interest.

FIG. 118. Spermatozoon.

In the male as in the female, the essential part of the reproductive system is the glandular structure that produces the sex cells. These cells in the male are called spermatozoa. They are long narrow cells having a head which is the nucleus, and a body which resembles a tail, called the flagellum, which has a whip-like motion giving the spermatozoon its ability to travel from its point of entrance throughout the female reproductive tract. A prodigious number of them are produced during life.

The organs in which the spermatozoa are produced are called the testes. They are located in a pouch of skin called the scrotum, which is suspended from the lower part of the male pelvis. The scrotum is lined with serous membrane and contains the two testes with the tubes leading from them. Each testicle is about the size of a walnut. It consists of two parts, a cellular portion which produces the sex cells, and a

tubular part called the epididymis. The cellular portion consists of about 800 very fine coiled tubules, each more than a foot in length when unravelled. From the lining of these tubules the spermatozoa are formed. From cells which lie

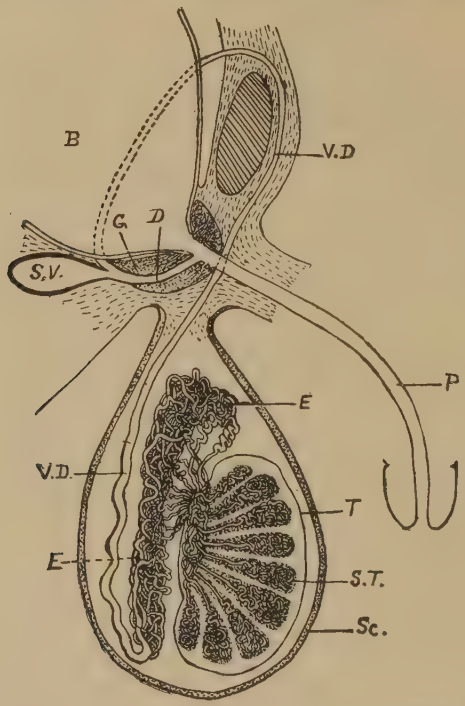


FIG. 119.—A diagram of a sectional view of the essential sex organs of the male, seen from the right side. The section is supposed to pass chiefly through the middle plane of the body. B, the bladder; P, the urethra passing through the penis; Sc, scrotum containing the testis; T, testis, consisting of sperm tubules; S.T., sperm tubules where sperm is formed. E, epididymis, a much-coiled tube which receives the sperm through tubes from all parts of the testis and conveys it to V.D., the vas deferens. This tube leads to a reservoir, S.V., and finally to the outside world through the ejaculatory duct, D, and the urethra, P; the prostate gland G. (*Galloway's "Biology of Sex."*) (*Bundy.*)

between the tubules is produced the internal secretion which furnishes the primary sex characteristics and impulses, and also the secondary ones that give male physical qualities. These cells are called interstitial, because they are found in the connective tissue between the sperm-bearing cells.

The sperm tubules unite to form the tubes of the epididymis, which later in its course is called the vas deferens. This tube leaves the scrotum and winds upward in front of the pelvic bones in the groin, enters the abdomen and proceeds to the seminal vesicles located between the bladder and the rectum. The seminal fluid from the testicles is collected in these vesicles, from which ducts lead outward to empty into the urethra.

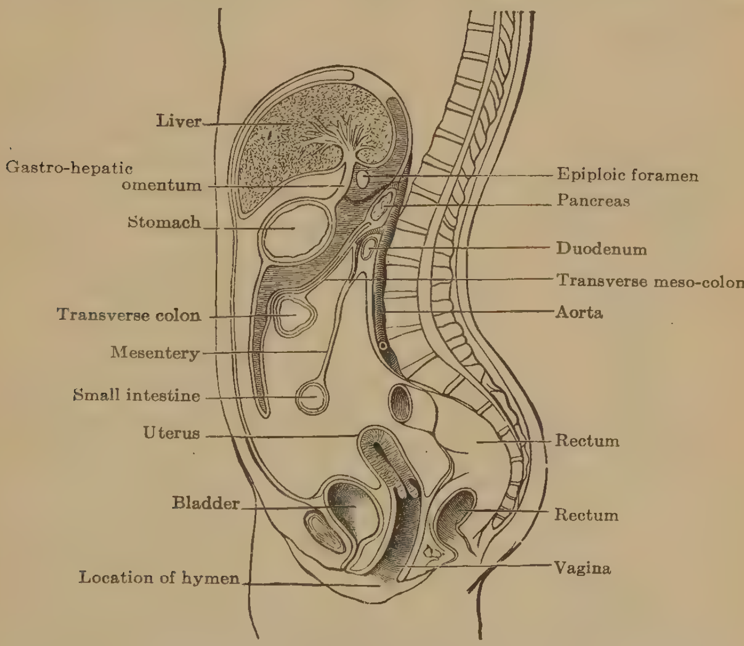


FIG. 120.—Diagram to show a cross section of the female genital tract. The section passes through the middle plane of the body, and thus does not show the Fallopian tubes and the ovaries, which are located at either side of the uterus. The walls of the vagina are ordinarily in contact with each other, and its opening is partly closed by the hymen in the virgin. (*Bundy.*)

The seminal fluid leaves the seminal vesicles because of contraction there during sex excitement. The route of the seminal ducts is directly through a gland called the prostate which adds a secretion to the seminal fluid. In its final form the seminal fluid, spermatic fluid or semen consists of a thick whitish liquid chiefly from the tubules of the testicles, the seminal vesicles and the prostate gland, all serving as a

vehicle for the spermatoza. Only a small amount of it is discharged at a time, the interval varying according to the rapidity with which it forms. Spermatozoa continue to be developed in the male until an advanced age. Aside from possessing motility these cells possess great vitality, and may live for days after entering the female reproductive tract. Occasionally a male is sterile, or incapabable of reproduction, because the seminal fluid contains no living spermatozoa.

Both the seminal fluid and the urine leave the body by the same route, by means of the urethra which passes down through the penis, an organ containing muscle and many blood vessels capable of being filled to engorgement. This makes the penis larger and firmer for its introduction into the vagina during coitus, in order to place spermatozoa in a favorable location for coming in contact with an ovum. Because it becomes more erect when it is thus engorged the process is known as erection. Although erection is physiologically purposive it takes place at times under other circumstances, either as a result of local stimulation, such as that produced by the accumulation of semen; or as a result of psychic stimulation by erotic thoughts or emotions.

Fig. 121. — Thickened lining of uterus; showing imbedded ovum after impregnation. (*Bundy.*)

In males, from the time of puberty onward, the seminal vesicles occasionally become distended with fluid, which may occasion a slight feeling of tension locally. The fluid will be automatically discharged after a time, usually during the night. Nocturnal emissions, as they are called, may be accompanied by sex sensations, which are often perceived as a part of a dream. They are entirely normal, although some males do not experience them. Frequently they occur as often as once in two or three weeks. There is a general and false impression that they are harmful, or even disgraceful. Such is not the case. They represent merely the overflow from distended vesicles, and are as normal in their way as menstruation is in females.

The female reproductive organs consist of the ovary (analogous to the testicle in the male); the oviducts; the uterus; and the vagina.

The ovaries are small glandular organs about the size and shape of a large almond, located one on each side of the pelvic cavity. They contain a large number of single cells, called ova, each contained in a small sac called the Graafian follicle. In the adult ovary there are found ova that are very immature in form, others more developed, and others reaching their full maturity. The most mature ova will be found near the surface of the ovary, and about to go through a process called ovulation. This consists of the rupture of the enlarged Graafian follicle and the discharge of the ovum into the peritoneal cavity. This happens about every twenty-eight days, only one ovum maturing at a time. Ovulation does not begin until puberty, at which time also menstruation begins. Before then, since no ova are produced, pregnancy cannot take place.

The ovary produces also, besides the ova, an endocrine secretion which is responsible for the appearance in the female at puberty of the secondary female sex characteristics.

The uterus is an organ about the shape and size of a small pear, and is composed largely of involuntary muscle. It has a cavity which communicates with two tubes, one on each side at the upper part. Both the uterus and these Fallopian tubes are suspended in the broad ligament across the pelvis. The uterus is also supported by other ligaments, but it is relatively freely movable. It lies between the bladder and the rectum. Ordinarily it is tipped at an angle, with the upper part nearer the front of the body.

The Fallopian tubes extend outward toward the side of the body, and have open ends which lie near the ovary. As the ovum is discharged from the ovary, it is taken up by the finger-like processes on the end of the tube. The tube is lined inside with ciliated mucous membrane, the cilia having their strongest motion in the direction of the uterus. The ovum is therefore wafted along at a slow rate through the tube. It is in the tube that it is met by the spermatozoon and fertilization takes place.

The lower part of the uterus is called the cervix. It is so situated as to project into a tube called the vagina, which opens upon the exterior of the body. It is through this tube that the menstrual blood is given off; that the spermatozoa enter the body; and that the child is born. Its outer opening is partly closed in the virgin by a thin membrane called the hymen, which is likely to be ruptured by chance during childhood, but often remains intact until the first sexual intercourse.

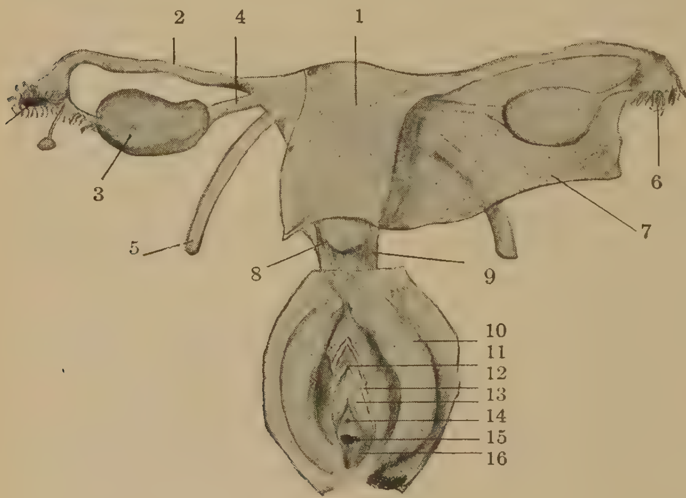


Fig. 122.—Reproductive organs of the female. 1. uterus; 2. Fallopian tube; 3. ovary; 4. ovarian ligament; 5. round ligament; 6. fimbriated end of tube; 7. broad ligament; 8. cervix of the uterus; 9. vagina; 10. labia majora; 11. clitoris; 12. labia minores; 13. vestibule; 14. orifice of urethra; 15. orifice of vagina; 16. hymen.

The vagina is lined with mucous epithelium, producing ordinarily a small amount of secretion. The opening of the vagina lies between the urethral and anal openings. The external genitals consist of two folds of tissue called labia. Where the two unite there is a structure called the clitoris which contains many nerve fibres, making it particularly sensitive.

The function of menstruation seems to bear some relation to that of ovulation. It is known that each process occurs at about a twenty-eight day interval, although not simultane-

ously. Each process begins at puberty and continues to the climacteric (menopause; "change of life"). Removal of the ovaries causes cessation of the menstrual function. It is generally thought that at the time of ovulation an internal secretion is produced by the ovary that activates changes in the lining of the uterus. These changes consist of swelling and congestion of the mucous membrane in preparation for the reception of the fertilized ovum. The many capillaries become filled with blood. If pregnancy occurs, the engorged mucous membrane serves to supply a resting place for the ovum. If the ovum is unfertilized it is cast off, together with the blood that oozes for three or four days from the capillaries. After fertilization of an ovum menstruation does not usually occur again until after delivery of the child, or after lactation is over if the mother nurses the child.

The uterus goes through a resting phase; a phase of preparation for menstruation; the period of menstruation itself; and a period of restoration after menstruation, during which time it is thought that another ovulation is taking place. There seems to be little foundation for the belief that this phase is more favorable for fertilization than any other.

The fact that menstruation is produced by a hormone of the ovary which circulates in the blood is borne out by the fact that symptoms remote from the uterus may occur during menstruation that cannot be attributed to any changes there. For example, the breasts become slightly full and often painful. That the production of this internal secretion is something quite apart from the production of ova is shown by the fact that pregnancy may occur in women who do not menstruate or do so only rarely.

The mammary glands or breasts are accessory reproductive organs in the female. An undeveloped sort of breast is found also in the male. The mammary glands are masses of secreting epithelium which do not function until after delivery of a child. Occasionally they do not function even then, which is unfortunate since the fluid secreted is the most suitable food for the infant.

The inactive mammary gland is largely composed of fat and connective tissue with gland tissue in rudimentary form. The

size of the breasts is due partly to the individual tendency to fat deposits, but it is thought that it is also due to the activity of the ovarian internal secretion. It appears probable that under-development of the breasts may be due to under-secretion of the ovaries.

The process of fertilization consists of the union of the spermatozoon with the ovum. The spermatozoa in the seminal fluid are deposited in the vagina, and from there travel through the uterus to the Fallopian tubes. If an ovum is there the spermatozoa swarm about it and finally one becomes united with it and the others seem actively to be repelled and die.

The nucleus or head of the spermatozoon becomes fused with the nucleus of the ovum, the rest of the spermatozoon being lost. The new single nucleus is the earliest stage of the life of the new individual. It moves through the Fallopian tube until it reaches the uterus, where it is implanted in the mucous membrane that has been prepared for it by the engorgement of its capillaries. The zygote, as this single cell is called, immediately divides into two parts, each part containing an equal part of the nuclear material and the contained inheritance substance. In the case of twins, two ova may be developed at the same time, in which case the twins are not identical; or one ovum may be developed, and each half after the first division go on to independent full development, in which case the twins are identical.

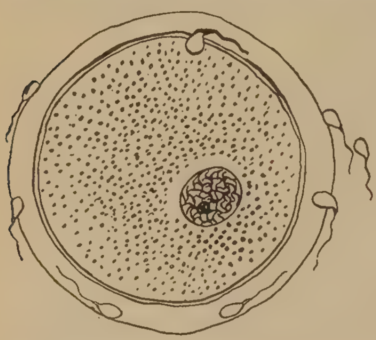


Fig. 123.—Spermatozoa about an ovum, one entering it.

The subsequent course of events in the developing embryo involves the continued rapid dividing of the cells already formed, until there are the millions of cells that constitute the new-born child.

Quite early there forms about the developing embryo a sac called the amniotic sac, which surrounds the embryo entirely. In it is fluid in which the embryo floats. It acts as a hydrau-

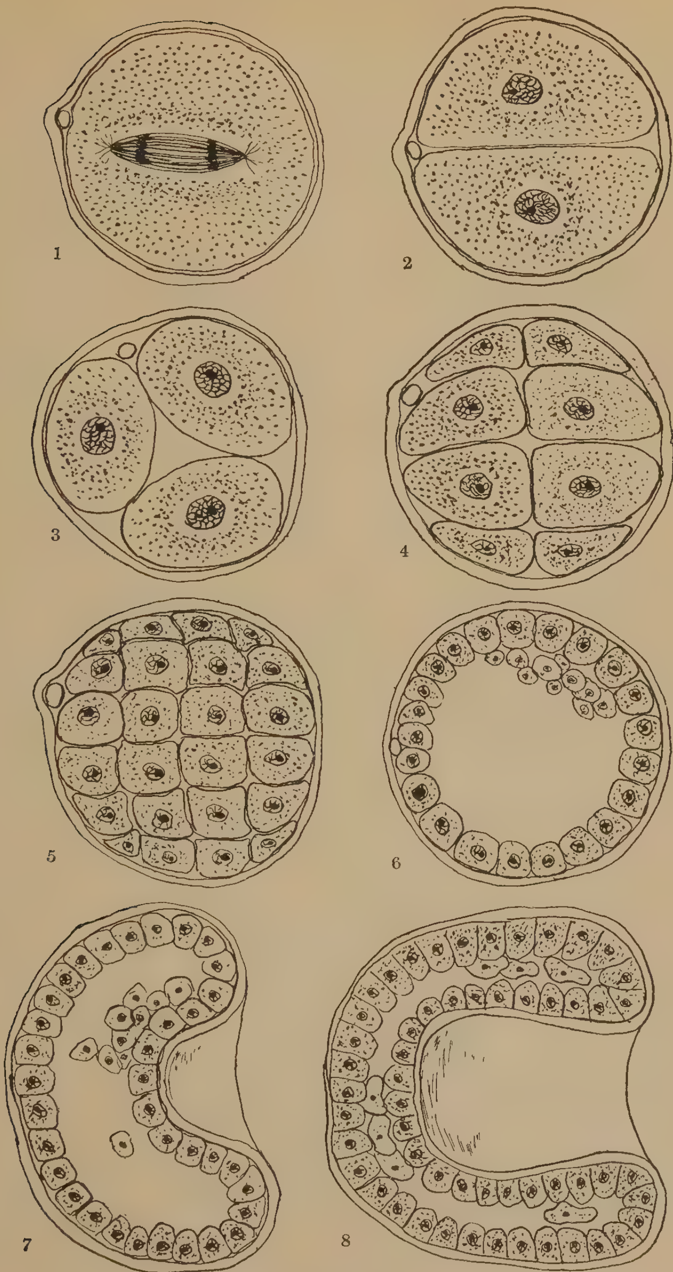


FIG. 124.—Cell division, as it takes place after ovum and spermatozoon have become one cell.

lic cushion to protect the embryo from too sudden changes of pressure.

As the ovum takes its position in the uterus, it becomes attached closely to the uterine wall, from which it draws its nourishment. At one spot the mucous membrane and the sac which develops around the ovum both become thickened and many blood vessels develop. This is the site of the formation of the placenta, a large mass of blood vessels which communicates on the one hand with the maternal blood vessels in the uterine wall and on the other hand with the blood vessels which develop in the child. At the time of delivery of the child, the placenta is very large and connected by a cord to the abdominal wall of the child. In the cord are the umbilical blood vessels that have carried blood from the mother to the child, bearing its nutriment and oxygen; and those from the child to the mother, carrying away its waste and carbon dioxide. After the child is born, the vessels are cut near the abdominal wall, leaving a dimple where they heal, called the umbilicus.

At a very early stage in the subdivision of cells, there appear three layers of cells which begin to fold about in such a way as to form the dorsal and ventral cavities of the body. At about four months after conception (union of ovum and spermatozoon) the embryo has distinguishable eyes, ears, fingers and toes, and its sex is apparent. From then on it is called a foetus. It may live if born after only six months but the full time of intra-uterine life is two hundred and eighty days after conception or ten lunar months.

The mother merely carries the developing child, provides it with nourishment from her own blood and carries off its waste. Aside from the quality of her blood and the effect her health has on its quality, the child is uninfluenced by the mother. It may, in respect to some diseases, become infected through her blood being infected, or it may be poorly nourished if she is poorly nourished. It may receive poisons from her blood. It may become injured by accidental mechanical violence to the mother. It cannot, however, be affected by "maternal impressions" or in any way "marked" by anything the mother does or feels—popular superstition to the contrary.

There is no nerve connection of any kind between the mother and child.

Birth consists of the delivery of the child by a process of contraction of the uterine muscle and of the abdominal muscles. The child passes through the vagina, which is capable of great distension. Usually the amniotic sac ruptures first, or during delivery, and its fluid escapes. Then the child is born, and finally the placenta separates itself from its attachment to the uterine wall and is discharged.

During pregnancy the uterus has increased enormously in size, and its muscle cells have increased in number so that it is capable of great contracting power, which it needs to expel the child through the birth canal. Since this is an entirely natural and normal process, it is usually accomplished without much difficulty. After the child is born, for a number of days the uterus gradually shrinks, finally regaining nearly its former size.

The average weight of the new-born child is seven and a half pounds and its length about twenty inches. The child as soon as it is born gasps or cries and fills its lungs with air, certain changes takes place in its circulation and it is ready for life. It does not "come to life" at birth for it has been alive from the time of conception on. It has had for some time before birth its own heart and blood vessels and nerves. It has had all of its organs, some of them functioning as fully as they ever will although in a somewhat different way. It takes a little time after birth for some of the functions to adapt to life in the outside world, but with intelligent care the new-born infant should be almost as hardy as an adult.

[illegible] — within } endocrine.
[illegible] — [illegible]

CHAPTER XVII

THE ENDOCRINE SYSTEM

The organs of this system have already been mentioned as glands that produce secretions that, instead of leaving them by ducts, go directly into the blood stream. They are therefore called glands of internal secretion, or endocrine glands. The products of these glands are called internal secretions or incretions.

These secretions are formed, as are all secretions, from the material brought to the glands by the blood and elaborated

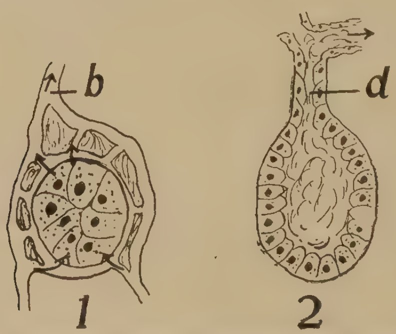


FIG. 125.—1, gland producing internal secretion, which enters *b.*, a blood vessel; 2, gland producing external secretion, which enters *d.*, a duct leading to a surface.

within the individual cells of the glands. Each endocrine gland has a very large blood supply, takes out of the blood what it needs to make its product, and turns back into the blood its own secretion which is unlike that of any other organ.

The internal secretions are all hormones—that is, they are produced in one part of the body to be carried away and used elsewhere. Other examples of hormones have been cited. Most of the endocrine glands are thought to produce more than one hormone, or at least to take part in the regulation of several bodily functions.

great

3 Ossified sometimes!

It should be noted that these glands appear to form a system and to be in close association with each other functionally. For example, one gland may produce a hormone that acts to check a hormone produced by another of the glands. Or one gland may produce a hormone that acts in support of another and may be able to take its place if it fails. The interaction of these glands is just beginning to be understood, and very little may be stated as demonstrated to the satisfaction of all. So close is the relationship between glands thought to be, however, that it is considered unlikely that one gland may be disturbed in function without causing others to be disturbed. The secondary disturbance in the other gland is thought likely to be often of a nature to compensate for the defect in the primarily disturbed one.

The endocrine system, by its numerous hormones, provides a means of regulating body functions chemically. It has been seen how the body functions are regulated by the nervous system. Parallel to it is this chemical means of activating and inhibiting functions. The nervous system itself stimulates endocrines, however, and the endocrines stimulate the nervous system. For example, mental and nervous states may upset the thyroid gland, and thereafter the thyroid may seriously affect the nervous system.

Although the endocrine hormones affect many functions, there are several functions that are especially under their influence. Among these may be mentioned: growth and development of the skeleton; muscle and adipose tissue development; the development of the sex organs and their functions and of the secondary sex characteristics; the amount and distribution of hair; the rate of general metabolism; the metabolism of carbohydrates; the metabolism of calcium; possibly blood pressure; and probably the responsiveness of the vasomotor system. Mental development and personality traits of several sorts seem definitely to be linked with certain endocrine conditions. These characteristics and functions are stimulated or inhibited at least partly, if not wholly, by endocrines, sometimes by a single hormone but often by the interaction of several.

Functions that go on at certain times in life and not at others need a good deal of regulation in order to appear when needed and to stop when no longer needed. In order to have growth go on up to adolescence and stop then, certain endocrines act in youth for this purpose and then cease to act. When growth is going on, sex development is quiescent, but after the endocrines producing growth cease to act, those that set going the sex development begin to function.

In certain circumstances all through life, the body needs to adjust itself very completely to conditions that arise, by changes in the distribution of blood, availability of energy-producing material and responsiveness of the nervous system. It is the function of certain of the endocrines to provide the quick changes of physiological function that enable an individual to meet adequately the emergencies that call for quick changes from inaction to action.

The glands that are exclusively for the production of endocrines are the pituitary at the base of the brain; the thyroid and the parathyroids in the front of the neck; and the adrenals or suprarenals, one on top of each kidney. In the pancreas and in the gonads (ovaries and testes) are certain cells that are for the purpose of producing internal secretions, as distinguished from the product of the other cells of these organs. There are other organs whose endocrine function is less important or less well understood, such as the pineal in the brain, and the thymus in the neck.*

* The thymus gland, located low in the neck, largely behind the sternum, is not definitely known to be an endocrine gland. It is largest before birth and in the first few years of life, and after puberty tends to disappear. It has been thought to act as an aid to skeletal growth, and to inhibit sex maturity until growth is attained. Some clinical observers believe that persistence of this gland after the time when it usually atrophies leads to large stature but sexual immaturity, and that the reverse is the case if atrophy occurs too soon. One of the known functions of the gland is the production of some of the white cells of the blood.

The pineal gland, or body (as it should be called, since it is not known that it produces a secretion) is thought to be the remnant of a primitive third eye. Disease of the pineal produces early physical and mental maturity, early sex development, and obesity, probably because of either an increase or a decrease or a change in character of an undemonstrated product of its cells.

Insulin, the internal secretion of the groups of cells known as the islands of Langerhans in the pancreas, has already been mentioned as the secretion that regulates the metabolism of carbohydrates. Although other factors enter in—small amounts of insulin-like material being found in all the body tissues—without the supply of insulin from the pancreas the body cannot make use of these substances as food. The lack of insulin represents the disease called diabetes, which is treated both by the regulation of the diet, and often also by the administration of insulin extracted from animal pancreatic tissue.

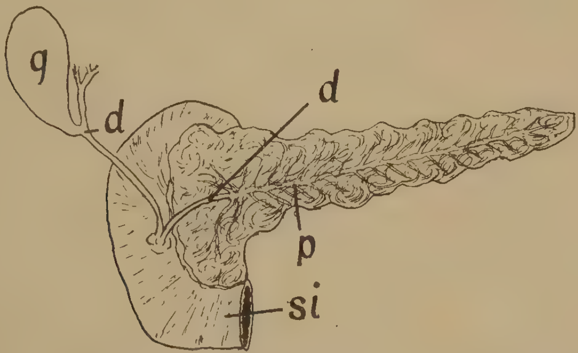


Fig. 126.—The pancreas. *p.*, pancreas; *d.*, duct from pancreas; *g.*, gall bladder; *d.*, duct from gall bladder; *si.*, small intestine.

Other glands that possess an especially important function are the parathyroids. If their secretion is missing, the body seems unable to make use of calcium, or lime, salts in the food. Since these salts are necessary to the body, it is apparent how important are the tiny parathyroid glands. An extract of them has recently been made available, which may be administered as an aid in supplying calcium lack in the body.

The pituitary gland has special significance in relation to skeletal growth. No other gland produces quite so spectacular results when it is out of order. If there is an excess of one portion of its secretion in early life, giantism results. On the other hand, certain other defects in its secretion give obesity. Extract of the pituitary gland produces increased tone of smooth muscle and raises blood pressure. The pituitary

gland consists of several distinct parts. It is probable that the secretion of each has different effects in the body, and that each has important functions that are closely related to those of the glands already mentioned and to those that remain to be discussed.

The gonads or reproductive glands produce the reproductive cells, but they also produce internal secretions that determine all physical characteristics that denote sex and all the mental and emotional characteristics that are involved in the reproductive or sex instinct. Without these important internal secretions the individual remains physically and mentally immature in respect to all matters pertaining to sex. Until the time when sex should develop, the action of these glands is held in abeyance by other glands. If the other glands do not at the proper time diminish their restraining influence, sex development of all kinds is delayed. If the sex glands themselves are removed before maturity, similar results follow. If they are removed after maturity, reproductive power and the sex impulses cease. They tend to atrophy (die) late in life, with similar results. Attempts have been made at restoration of function by the transplantation of gonads. The reproductive function cannot be restored and it is extremely doubtful whether any physical or temperamental changes are produced. The results described in current literature are almost wholly fictitious. About all that has been demonstrated scientifically is that transplantation of gonads in birds from one sex to the other produces a marked degree of reversal of sex characteristics.

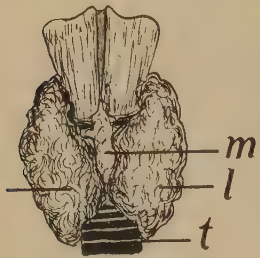


Fig. 127.—The thyroid gland. *m.*, medial lobe; *l.*, lateral lobe; t., trachea.

In women, menstrual difficulties are sometimes apparently due to a deficient supply of the ovarian internal secretion, or to an excessive supply. Clinical evidence, gained by the administration of an extract of ovarian glands, seems to show that the former difficulty is quite common in those who have not entirely reached sex maturity; and that at the time in middle life when menstruation ceases, symptoms are

sometimes produced because of the decrease in ovarian secretion and the increase in secretion of other glands.

The thyroid gland is most important in that it is responsible to a marked degree for the regulation of the rate of the metabolism of the body, and the activity of the nervous system. A slight amount of over- or under-secretion of this gland is very common. This may be determined, not by observation of the

Fig. 128.—Cretin before (A) and after (B) treatment with sheep's thyroid. (Bachmann and Bliss.)

gland to see whether it is enlarged, but by observing signs of increased activity of the nervous system, and thereby of the heart action, and by tests for the rate of metabolism. A change in the size of the gland has very little significance alone, for it may be enlarged and secreting too little, or normal in size and secreting too much. An increase in size is called goiter, but this may mean nothing regarding its function. It is very

common in certain parts of the world where there is too little iodine in the water supply. Because the secretion of the thyroid contains iodine, it must have iodine to elaborate its proper secretion, or symptoms due to the lack may follow. Therefore iodine is administered whenever the water supply is defective in this respect—that is, in many inland parts of the country.

If the thyroid gland is very defective in function, a condition known as cretinism results. In such a condition the mind is that of an imbecile and the body is stunted in growth and metabolises very slowly. If treated by the administration of extract of thyroid glands of sheep or oxen, many of the defects may be made almost to disappear. Minor degrees of lack of thyroid secretion (hypothyroidism) are treated in the same way with excellent results.

An oversecretion of the thyroid (hyperthyroidism) causes the whole body to metabolise very rapidly. Usually more food is taken without any increase in weight, or even with a decrease. The temperature may be slightly higher than normal unless the activity of the vasomotor system cools it by increasing the perspiration. The blood pressure is usually higher and the heart action more rapid. Mental activity is usually lively and there is a tendency to physical activity which often amounts to restlessness. The individual shows signs of "nervousness"—the hands tremble, tears come easily, and a general state of excitement is apparent, although the individual often feels also depressed and moody.

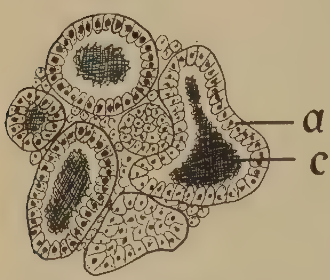


FIG. 129.—The thyroid gland, cross section. *a.*, gland cells; *c.*, accumulation of product of the cells.

If the condition is quite pronounced sometimes part of the thyroid gland must be removed in order to lessen the amount of secretion. But in slighter degrees of hyperthyroidism other measures are successful. One of the important measures is a modification in living habits, so that the individual does not suffer from the effects of the "drive" provided by the increase

of thyroid activity. It is sometimes hard to limit activity, because the impulse is to be more active than is desirable in such cases.

The adrenal glands produce a hormone called adrenin or epinephrin. An extract of the medulla of the gland is called adrenalin. It is as important as the thyroid in its effect on the nervous system. It has a normal function that is being continuously performed, but it has in particular an emergency function. Conditions that produce anger and the need for fighting, or fear and the need for flight, are met by an increase of adrenal secretion that helps the nervous system to mobilise the body forces to these ends very quickly. The blood pressure increases, the rate of the pulse and respiration is increased, there is a dilatation of blood vessels of the lungs and of the heart walls, and a dilatation of the bronchioles. All of these measures are for the purpose of making energy quickly available, by providing more blood, and blood with more oxygen, to the voluntary muscles that are about to act. There is also a dilatation of the blood vessels in the muscles themselves, to give them a fuller blood supply. At the same time there is contraction of the blood vessels in the alimentary tract so that they will not use the blood needed elsewhere. Most important of all, new large supplies of glycogen are taken from the liver storehouse and turned into the circulation to be available for the muscles. Coincidently, the clotting power of the blood is increased in order to minimize the harm from possible bloodshed. The adrenal gland thus helps to prepare for what is likely to happen in circumstances that arouse emotions. The emotions themselves are a part of the whole process of adaptation to external circumstances. What one perceives of all these changes is the emotion aroused. Civilized man does not have so violent emotions, because the original stimulus of the adrenal, and of the thyroid which acts in a somewhat similar way, may be perceived rationally and all this machinery may not therefore be so fully activated. Man acquires knowledge

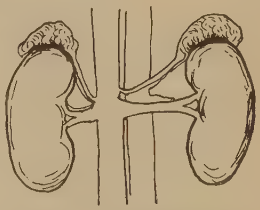


Fig. 130.—The adrenal glands, above the kidneys.

of what to fear and when to be angry, and these glands need not to be stimulated unnecessarily.

It is not only in emotional emergencies that such changes as have been mentioned take place. Any necessity for increased energy production gives similar results. The responses are aroused in those about to take part in competitions, either physical or mental. A basketball game or a spell of "cramming" is made possible by the increased energy production made available by sympathetic nerves in cooperation with the adrenal medulla. The fact that such increased energy does come when needed is not recognized by those who are never challenged to make a supreme effort. There is some danger, however, in allowing one's self to be perpetually challenged, for the reaction that is normal in emergencies is excessive for everyday living. The viscera, for example, cannot be too frequently deprived of their usual blood supply without interfering with digestion and excretion.

Not only are many bodily traits and physical functions, but also many personality traits, due to the predominance of one endocrine over the others. It has been seen how the thyroid gives signs of "nervousness" and the gonads increase sex interests and the adrenals increase the violent emotions and general activity. The so-called temperament of an individual —lethargic, nervous, excitable, depressed—is often if not always directly related to the secretion of the endocrines. This does not mean that such states of mind or body are necessarily permanent, for the endocrines change in the amount of their secretion from time to time. Nor does it mean that they are uncontrollable. Improvement in the general health by the practice of personal hygiene influences the functioning of endocrines as of all parts of the body. Furthermore, medical treatment frequently is able to help normalize endocrine function. As has been mentioned, the extracts of glands from animals are sometimes used to make up for a lacking or diminished secretion.

Study and experimentation are being carried on extensively with a view to enabling medical science to correct more of the defects in endocrine secretion in this way. Experimentation on human beings must always be made with extreme caution.

however, since the equilibrium between the various glands is very delicate and may be entirely upset. For this reason no endocrine preparation should ever be taken except under medical supervision.

No chapter on the hygiene of the endocrines is included, since their care involves the care of the whole body, and seldom necessitates measures directed especially toward them.

CHAPTER XVIII

THE EYE, EAR AND LARYNX

I. Eye

Vision is due to the perception by the brain through the optic nerve of vibrations that constitute light. Form, light, color, movement, texture, distance, and relative position are perceived according to the direction of the rays, their intensity or their rate of vibration.

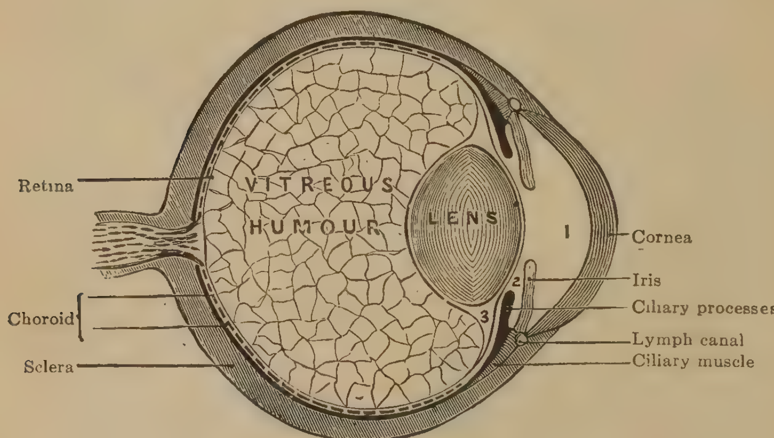


Fig. 131.—Diagram of vertical section of the eye. (Brubaker.)

The eyes are globoid in form, located in sockets in the head bones. At the back the eyeball is connected with the optic nerve, which passes backward from the eye through an opening in the skull to the brain. The motion of the eyeball is produced by a set of six muscles, so arranged that the eye may be turned in all directions. The corresponding muscles of each eyeball normally act in unison, so that both eyes are turned on the same object at the same time.

Over the front of the eyes are the upper and lower lids, with muscles to enable them to be closed or opened voluntarily or reflexly. The lids are valuable for the protection of the eyeball, since by closing the lids many kinds of injuring agents may be shut out; and also of the sense of sight, since by closing the lids light may be shut out. On the edge of the lids are lashes to protect the eyeball by catching what they may of the foreign matter that approaches it, and to afford some shade against too bright light.

At the edge of each lid are glands producing an oily secretion which helps to keep the eye moist. The further moistening of the eye is done by the lachrymal glands, located at the outer upper corner of the orbit. These glands open by a number of ducts on to the under side of the upper lid. They secrete constantly, the excess being drained off imperceptibly by ducts communicating with the nose. Their openings may be seen at the inner corners of the lids. Only excessive secretion overflows the lids. An excess is produced in emotion, especially in children, or in response to irritation of the eye.

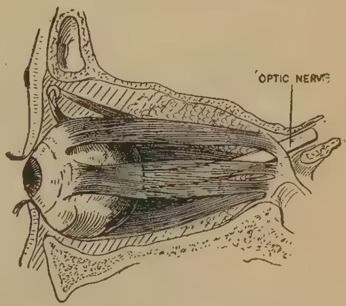


FIG. 132.—The muscles of the eye. (From Ritchie, "Human Physiology." Copyright 1908, 1915, 1920 by World Book Company, Yonkers-On-Hudson, New York.)

Inside the lid is the mucous membrane called the conjunctiva. Over the front of the eye it is transparent.

The eyeball is hollow, its walls consisting of several different layers of tissue, and its interior being filled with fluid. The outermost layer of tissue is called the sclera. It is this coat of the eye which is called the "white of the eye." The sclera covers the entire eyeball except where the optic nerve enters at the back. Over the colored part of the eye the sclera is called the cornea. It is in that area transparent. The cornea corresponds to the glass crystal of the watch.

The middle coat of the eyeball is called the choroid. It contains dark pigment to shut out light. At the point where

the sclera becomes the cornea, the choroid becomes the iris or colored part of the eye. The sclera and the choroid are in contact all over the eye except at this area. Here they are not in contact, as may be seen by looking at the eye from the side. The space between the iris and the cornea is filled with transparent watery fluid.

The iris does not extend completely across the front of the eye but has a perforation called the pupil, which varies in size according to the light admitted and the distance of the object looked at. It enlarges in dim light and in near vision. The

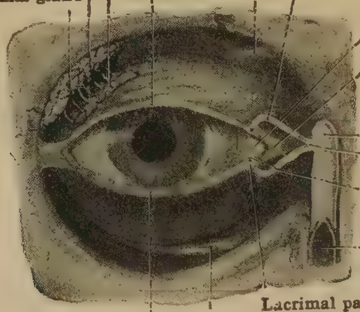


Fig. 133.—The lachrymal apparatus. (Morris' Human Anatomy.)

iris contains muscle fibers running in two directions, circularly around its open pupil margin and radially from the pupil margin to the iris margin. The former, when they contract, make the pupil smaller; the latter make it larger. The iris may be likened to the diaphragm in a camera.

At the point where the cornea and sclera become the choroid and the iris, there is a structure called the crystalline lens suspended across the eye vertically. It is round in shape and thinner at the edge than in the middle. It fits closely against the iris, and has in front of it the iris; the anterior chamber, containing fluid; the transparent cornea; and the transparent conjunctiva. All of the structures in front of the lens are

transparent except the iris, which is opaque but perforated by the pupil. Light, therefore, passes through to the lens freely, the amount depending upon the size of the pupil. All of the rest of the eye is opaque to exclude light.

The lens is also transparent, and composed of a jelly-like substance, not crystalline as the name would indicate. At the margin of the lens there is attached all about it a circular ligament which attaches it to the choroid coat. Since this ligament is attached to muscles which can contract, it is possible for the lens to be made thicker or thinner at need. It flattens when distant objects are looked at and becomes thicker for near vision. By referring to the principles of optics it will be seen

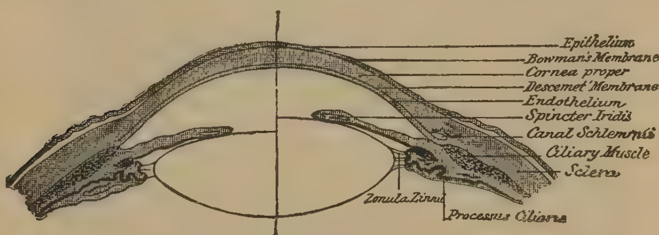


Fig. 134.—The left half represents the eye in a state of rest; the right half in a state of accomodation. (Brubaker.)

that the eye is adapted to cause rays entering it to converge to a varying degree. Because of this ability to cause rays to converge the field of vision is enormously widened. Without such a device one could see only that which is directly in line with the pupil.

The eye is sometimes likened to a camera, in that it can cause rays of light to converge. In the camera, however, focus is made on the film or plate by moving the lens back and forth. In the eye, focus is made by changing the thickness of the lens.

The retina is the third and innermost coat of the eyeball. It is analogous to the plate or film of the camera. Its cells are sensitive to light. When rays of light fall on the cells in the retina they are communicated from one layer of cells to another and finally set up nerve impulses that reach the fibers of the optic nerve. Hence they go to the visual center in the brain

where light is perceived. The cells in the retina undoubtedly contain chemicals analogous to the chemicals in the camera film, and undergo chemical changes at each visual impression. Unlike the film, the retina does not have to be changed for each picture. The instant one impression is recorded, the retina is ready to receive more.

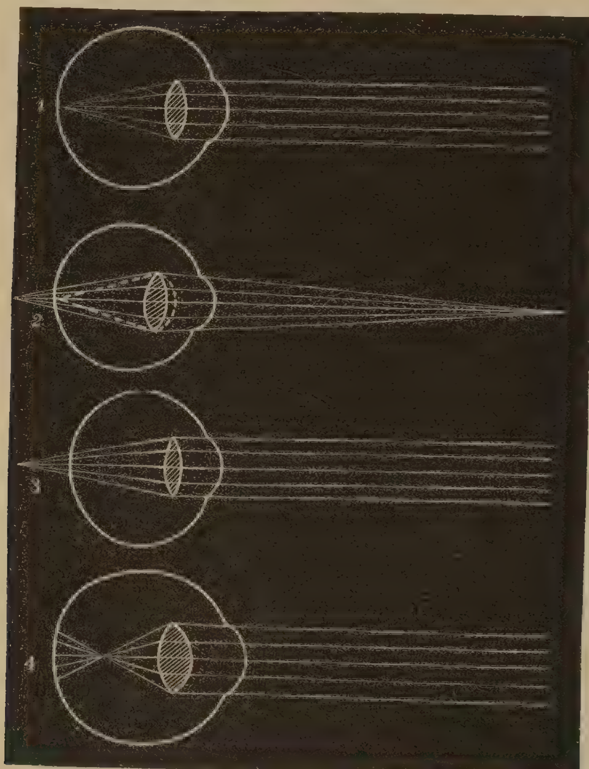


Fig. 135.—1. Normal eye; rays focusing on retina. 2. Normal eye adapted to near vision, by accomodation bringing rays to focus on retina. 3. Farsighted eye. 4. Myopic eye. (From Halliburton, "Physiology," 15th Edition.)

The term refraction when used with respect to the eye has exactly the same meaning as it has in physics. Refraction implies the bending of rays of light as they pass through various media. In the eye these media that bend rays are the cornea and the lens. In a normal eye the focusing mechanism of the

lens and the shape of the cornea are such that all rays from all objects in range focus exactly on the retina, and a clear visual image is received.

Beginning at about forty-five years of age even the normal eye loses some of its power to converge rays exactly on the retina, because the mechanism that changes the shape of the lens fails in its efficiency. Such eyes cannot without glasses converge on near objects, although they may still see well at a distance. This is called loss of accommodation or presbyopia.

The process by which focusing is accomplished is as follows. At the junction of the suspensory ligament of the lens and the choroid coat there is a small muscle which is circular about this part of the eyeball. When it contracts it pulls the choroid coat tighter, and thus relaxes the suspensory ligament, at the same time causing the lens to thicken. This is called the act of accommodation. It takes place when objects that are near by

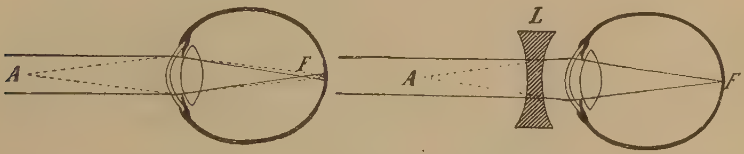


Fig. 136.—1. Myopia, nearsightedness; parallel rays focus at F, cross, and give blurred vision. Divergent rays from A focus on the retina and give clear vision. 2. Correction of myopia by a concave lens. (Brubaker.)

are looked at. In distant vision accommodation is relaxed—the muscle relaxes, the ligament tightens, and the lens flattens. The muscle is called the ciliary muscle.

If accommodation can not be performed (i.e. if the ciliary muscle will not produce a change in thickness of the lens) the image will not be on the retina, and therefore not clear. It is only when rays fall exactly on the retina that vision is clear. The failure of accommodation in older years is due to a hardening of the lens and of the choroid, so that the choroid does not pull forward nor the lens change shape, even though the ciliary muscle acts.

Lack of clear vision in youth is commonly due to one of three causes: the eyeball may be too long from front to back,

or too short from front to back, or there may be irregularity in the curve of the cornea or of the lens.

When the eyeball is too long the individual is called near-sighted. The rays of light focus at a point in front of the retina, and there is no mechanism in the eye to make them focus farther back. The mechanism of accommodation is of no use because its action merely brings rays to focus farther forward, which is the defect already present in near-sighted eyes. For such an individual a concave lens placed in front of the eye corrects the visual defect by spreading the rays and making them focus farther back, i.e. on the retina. The near-sighted individual sees objects near at hand better than he does those at a distance. In fact, if objects are near enough to the eye they sometimes focus perfectly. Occasionally the point where vision is best is not more than a few inches from the eye.

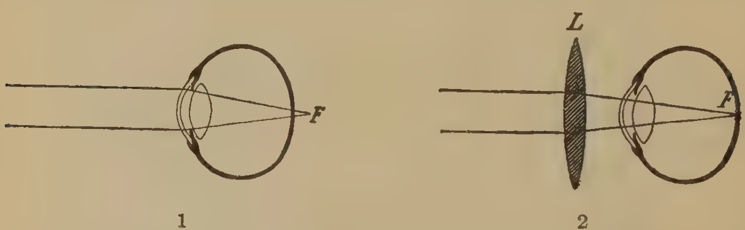


Fig. 137.—1, hypermetropia, farsightedness; parallel rays focussed behind the retina. 2, correction by means of a convex lens. F, focal point; L. lens in front of eye. (Brubaker.)

Objects at a distance are never seen well, without glasses, by the myopic or short-sighted individual.

When the eyeball is too short from front to back the individual is called far-sighted, or hyperopic. Often such an individual does not realize that he has any refractive error, since the mechanism of accommodation is adapted to correct it. Since the image in this kind of eye falls back of the retina, the apparatus of accommodation when it acts strongly will bring the focus forward, so that it is exactly on the retina. It is in this type of eye that strain is most likely to occur, because vision can be made satisfactory by the constant use of the ciliary muscle. Convex lenses correct this

defect by converging the rays and bringing them to a focus farther forward. This makes the extreme effort of the ciliary muscle unnecessary. The reason for the use of atropine in testing eyes is to paralyze temporarily the ciliary muscle, after which one may determine where the rays naturally would fall, and where the hard-working ciliary muscle forces them to fall. The far-sighted individual, even without glasses, may see perfectly well both near-by and distant objects, by hard work of the ciliary muscle.

When there is irregularity in the curve of the cornea, vision is blurred necessarily, because part of the rays are bent in one direction and part in another, so that they never come to an exact focus. In order to correct this refractive error there must be worn in front of the eye a lens that is convex where the cornea is flattened and concave where the cornea is overcurved. Without glasses, even though the ciliary muscle is used, it is not possible to make anything quite clear. This defect is called astigmatism. It will be seen that the prescribing of glasses for this kind of eye requires special skill. Myopia or nearsightedness never entails strain of the muscle of accommodation. Hyperopia or farsightedness entails its strain in both near and far vision. In the normal eye the ciliary muscle is not used for distance, but only for focusing on near objects.

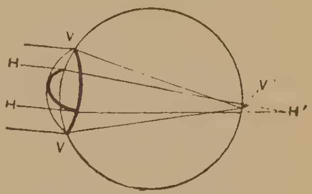


FIG. 138.—Astigmatism. No single focus can be formed. (Bachmann and Bliss.)

There is a sort of pseudo-nearsightedness which may occur in normal eyes when there is persistent contraction of the ciliary muscle, which cannot be relaxed. This makes images fall in front of the cornea as long as the spasm of the ciliary muscle lasts. It usually passes away of its own accord in time.

Visual impressions are of many different varieties. It is thought that there are special cells in the retina for the perceiving of color, and others of light. Estimation of size and distance is dependent on experience that enables one to interpret the sensations associated with the use of the ciliary muscle;

on the sensation produced when the two eyes converge on an object; and especially on the sense of perspective gained by using two eyes at the same time, each of which sees the object from a slightly different angle. There are many ways in which visual impressions are interpreted by means of afferent impulses in addition to the visual sensations carried by the optic nerve. Good vision demands that all parts of the eye be acting well in order that all of the sensations be properly interpreted.

II. Ear

The organ of hearing consists of three parts; the external, the middle, and the internal ear.

The external ear consists of a cartilage shaped so as to act as a receiver to collect sound waves. In animals it may be directed toward sound, but man has lost the ability to move the external ear thus.

Extending inward from the external ear is a canal called the auditory meatus, which communicates between the exterior and the middle ear. It is lined with skin, for part of its extent, whose glands produce a secretion called cerumen, which is usually cast off in imperceptible flakes.

The middle ear is located at the inner end of the meatus. It is an irregular, roundish cavity, separated from the meatus by a thin translucent membrane called the tympanic or drum membrane. In the drum membrane is lodged one end of a very small bone called the malleus. The other end of the malleus is connected with another small bone, and this with a third. This chain of three small bones (ossicles) stretches across the cavity of the middle ear. The inner end of the third bone fits into an opening in the bone which separates the middle ear from the inner ear. The function of the ossicles is to vibrate when sound waves strike the drum membrane from outside. Sound travels as waves on the atmosphere because of molecular vibrations. No results would follow the vibrations of the ossicles, however, if it were not for the fact that they communicate with the inner ear, where are located the cells that catch the vibrations and carry nerve impulses to the brain where they are perceived as sound.

From the middle ear leads a tube (Eustachian or auditory) which connects with the pharynx. The tube is about an inch and a half long, and its lining, like that of the middle ear, is

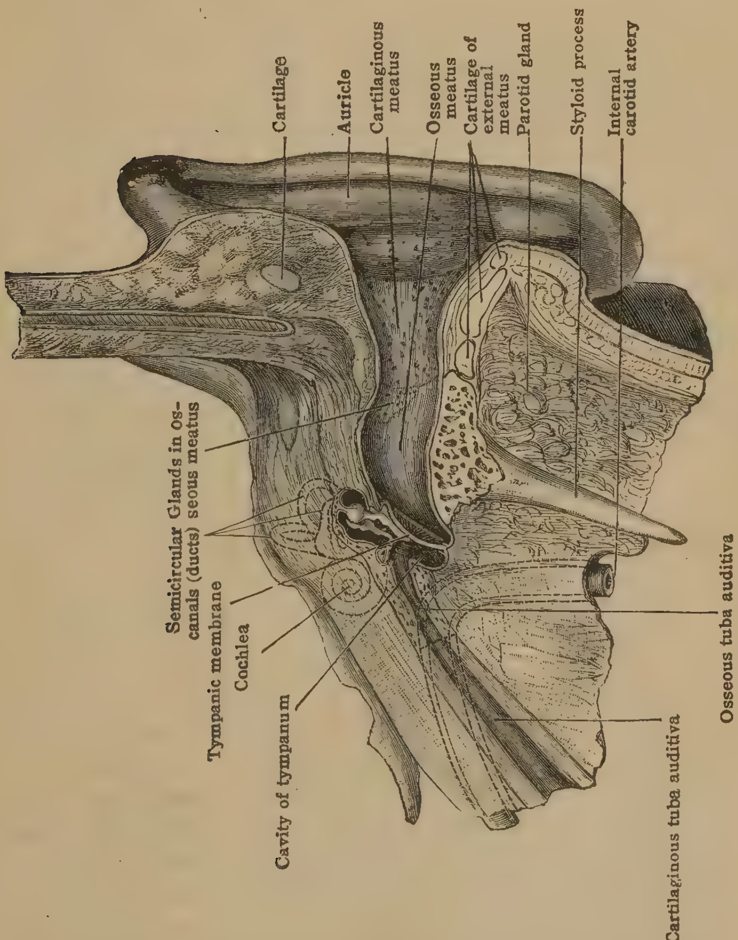


FIG. 139.—Vertical section of the middle and external ear. (Bachmann and Bliss.)

continuous with the mucous membrane of the whole respiratory tract.

The inner ear is a very complex structure which it is not necessary to describe here. It may be said, however, that it consists of two parts, one of which contains fluid which begins

to vibrate when the ossicles in the middle ear are set in motion. In the fluid are cells that catch the vibrations and transfer them to the many minute filaments of the auditory nerve. The auditory nerve endings are sensitive to sound vibrations only. When certain of them are stimulated perceptions of certain sounds are registered in the brain.

The other portion of the inner ear consists of the semicircular canals of which there are three. They are filled with fluid also, but do not receive the sound waves. Instead they

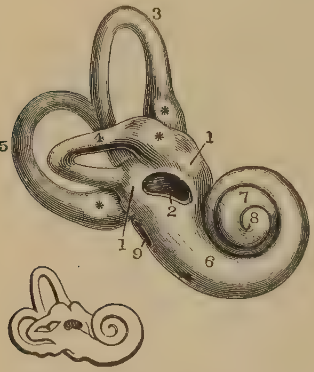


Fig. 140.—The bony labyrinth of the inner ear. 1., the vestibule; 2., oval window, to middle ear; 3., 4., 5., semicircular canals; 6., 7., 8., cochlea; 9., round window, to middle ear. (From Halliburton, "Physiology," 15th Edition.)

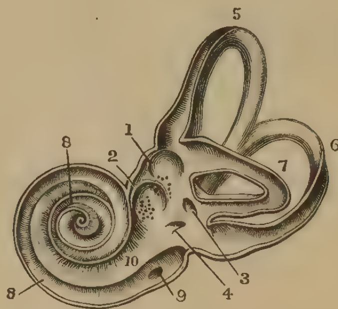


Fig. 141.—Interior of bony labyrinth. (From Halliburton, "Physiology," 15th Edition.)

are concerned in communicating to the nervous system knowledge of changes in position. When equilibrium is disturbed by motion of the body involving the head, one of the semicircular canals registers if the motion is a forward and backward one; another if the motion is from side to side on the vertical axis; and another if the motion is that of changing the axis of the body laterally from vertical to horizontal. Other motions of the head affect each of the three to some extent. If the semicircular canals are out of order dizziness or vertigo may result. This is rarely permanent, however. Seasickness is probably due to the inability of the nervous system to cope

with the many conflicting impulses from the overacting and disturbed semicircular canals.

It should be recalled in this connection that there are two other aids to the maintenance of equilibrium. One is the kinaesthetic or muscle-joint sense; and the other is the aid given by the sense of sight when the eyes are fixed on a stationary object. The proper functioning of the semicircular canals in particular must always be tested in those who expect to become aviators.

Deafness is due to several causes. It may be due to failure of the auditory centers in the brain to perceive the messages that are sent in from the inner ear; or to disease in the auditory nerve, or its endings in the inner ear; or to changes in the middle ear which make it impossible for the ossicles to vibrate; or to the closure of either of the passages to the middle ear, the auditory tube or the external meatus.

Back of the middle ear is found the mastoid portion of the temporal bone, in which are the mastoid cells. The mucous membrane of the respiratory tract not only lines the middle ear but even extends into these cells.

III. Larynx

The larynx is the organ in which sound is produced. The larynx is a box-like structure at the top of the trachea and continuous with it to the throat. It is composed largely of cartilages which are moved by various muscles in the neck. Stretching across the larynx are two folds of tissue called the vocal cords. They are capable of being contracted or relaxed, so as to make them more or less tense. When tense they approach each other more closely, and narrow the opening through the larynx. Some of the muscles in the neck are responsible for this tightening of the vocal cords. Across the top of the larynx is located the epiglottis, which is attached to the base of the tongue. It is so arranged as to cover the larynx when food is passing down, so that the food goes not into it but into the esophagus.

If air passes through the larynx when the vocal cords are relaxed no sound is heard except that of the breath. In order to make the more or less musical sounds of speech and

singing, the vocal cords must be rendered tense. This is done by contracting the muscles to which they are connected by means of intervening cartilages. The sounds that issue through the larynx in phonation are produced by the breath which causes the vocal cords to vibrate, as the string of a musical instrument vibrates when acted upon by mechanical

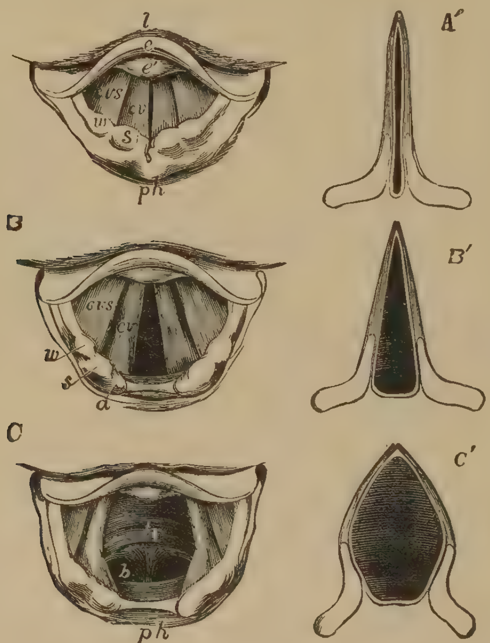


FIG. 142.—*A.*, the glottis during the singing of a high note; *A'.*, the vocal cords approximated for the purpose; *B.*, the glottis during ordinary breathing; *B'.*, the vocal cords and their cartilages during ordinary breathing; *C.*, the glottis during deep inspiration; *C'.*, the vocal cords and their cartilages during deep inspiration. (From Halliburton "Physiology," 15th Edition.)

force. In the piano the strings are hit by hammers. In the violin they are drawn on by a bow. In the voice the breath is the motive power that sets them vibrating. The cords may be drawn more or less tight as a high or low pitch is desired. The deeper voice of men is due to the longer cords men habitually have. Most women and children have short cords, hence higher pitched voices. The pitch of the voice may

rise in excitement because of the reflex tightening of the vocal cords.

The volume of the voice is due to the quantity of air expelled and the force with which it is expelled. It is also due to the character of the resonance chambers in the head. The quality of the voice depends upon the control exerted over the contraction of the vocal cords and over the exit of the air. It is also dependent on the anatomical structure of the resonance chambers of the throat, the nose and the nasal sinuses, and the degree to which they are utilised in vocalisation. Distinctness of articulation depends on the use of the consonant-

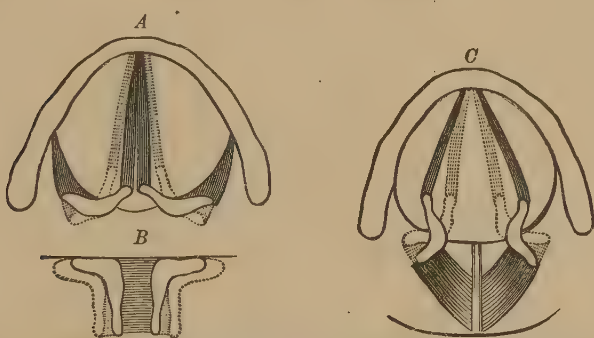


Fig. 143.—Relative position of vocal cords and their cartilages when tense and relaxed. (From Coakley, "Diseases of the Nose and Throat." Courtesy of Lea and Febinger, Publishers.)

forming structures—the lips, tongue, teeth, and palate. Both quality and distinctness depend to a great degree on the direction given the outgoing air by the throat structures. The voice may be so directed that the quality is muffled and articulation unclear.

The nasal voice is one in which the voice does not utilize the nasal resonance chambers properly. If these chambers are closed or blocked by secretion they are not used as intended and the voice is called nasal, because its quality is adversely affected by the faulty use of the nose in sound production.

The vibrations of the vocal cords are strengthened by vibrations in the lungs, trachea, mouth, nose and sinuses. The voice is affected by defects in vibration in any of these places.

Abdominal breathing sets the chest structures vibrating more largely than upper costal breathing, and gives more amplitude and better quality to the voice. The air is also under better muscular control when it is expelled by the slow powerful motion involved in lower costal, diaphragmatic or abdominal breathing. In whispering, the vocal cords are not used, but the breath is expelled through them and shaped into consonant form by the structures of articulation.

PART III

PATHOLOGICAL CONDITIONS

CHAPTER XIX

INFLAMMATION AND REPAIR

a. Inflammation

One of the most interesting physiological processes of the body is that which goes on in tissues when they are injured. There are many ways in which tissue is injured, and a large number of them excite activities of the circulation, of the blood and its corpuscles and of the injured part itself, which are comprised under the term inflammation. Only a few injuring agents fail to excite this response.

Inflammation occurs when there is mechanical injury, such as that involved in breaking of bone, in bruises and lacerations of the soft parts, and in sprains of muscles and joints. It also occurs in response to damage from heat and cold, or by electricity. Most strong chemicals also excite inflammation. Finally, bacteria in particular call out this body response.

The classical description of inflammation was given by Celsus before the Christian era. He mentioned four characteristics of tissue undergoing inflammation. They were *rubor* (redness), *tumor* (swelling), *dolor* (pain), *calor* (heat). A later investigator added a fifth characteristic, *functio laesa* (disturbance of function). In medical terminology inflammation is indicated by the suffix "-itis" (e.g. tonsil-itis).

What occurs in an inflamed region that causes all these signs to appear is an increase in the blood supply to the part. Such a condition of excess blood in a part is called hyperemia. The increase of blood is due to both active and passive causes—that is, a larger amount of blood comes in and a smaller amount goes away.

Just as normal circulation may be well studied in the transparent web of a frog's foot, so may the process of inflammation be studied. It is noted, first, that the rate of circulation

is slowed; and, second, that the white blood corpuscles approach the walls of the capillaries and that some actually pass through them. This is one of the purposes of the increased blood supply—that the white cells may pass out into the injured tissue.

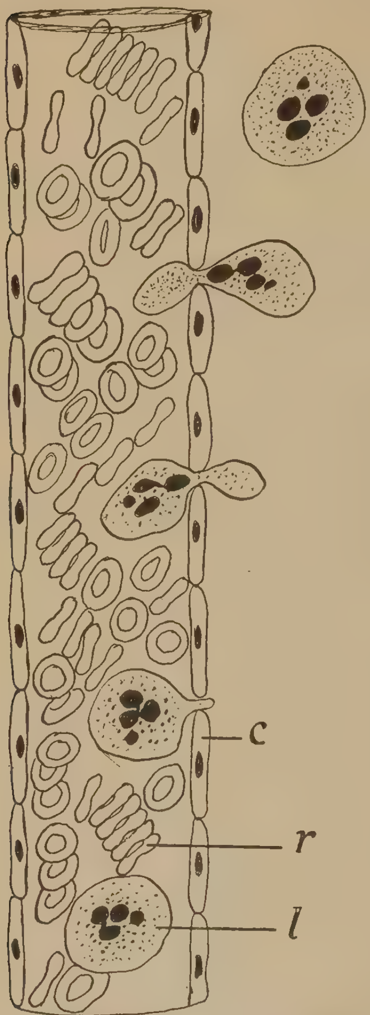


FIG 144.—Ameboid white cells passing out of a capillary. Diapedesis. *c*, capillary wall, endothelial cells; *r*, red corpuscles; *l*, leucocytes.

The symptoms observed in inflammation are chiefly due to the hyperemia. The additional blood in a part gives it its increased feeling of warmth, its redness and its swelling. By pressing on the nerve endings, it gives also the pain. When the tissue involved is firm and unyielding, the pressure makes the pain more severe. Pain in bones and in teeth and within the skull and the sinuses, or within dense organs, such as the kidney, is more severe than that in elastic structures, such as the skin. Pulsations from the heart may cause a throbbing sort of pain in any inflamed area, however. The disturbance of function of the cells of the part is due partly to the actual destruction of the cells by the injuring agent, and partly to the pressure exerted on them by the swelling about them.

It has been noted that some of the elements of the blood ooze out of the slowed blood stream. They combine with the fluids produced by the injury of cells to form the liquid that is

always associated with inflammation, and is called the inflammatory exudate. This is the moisture that is found on surface wounds, the liquid contained in a blister, or the "water" that forms in a joint after sprain. In the latter case the exudate is often merely an increase in the amount of fluid that is normally present. The same is true when mucous surfaces are irritated, the normal amount of secretion being increased.

The exudate varies in character according to the extent and character of the injury. In a blister, it is merely the serum from the blood, and is called a serous exudate. Sometimes it contains bacteria and many white blood cells, in which case it is called purulent exudate, or pus.

Inflammation is the normal sequence of injury, and in some cases and in some respects it tends to limit the amount of harm that an injury does. The process itself, is, however, a pathological one—one that constitutes a diseased condition—and may, if not speedily checked, be seriously injurious. One of the ways in which inflammation is an advantage is that it calls attention to the fact that injury has occurred or is occurring. By the pain and swelling caused, for example, by pressure of too tight shoes, or by an infected tooth, the individual learns of the necessity for correcting the cause of the trouble. It is fortunate that most injuring agents do cause pain.

In addition to whatever efforts may be made by the individual to limit the damage, the tissues themselves, if they are given a fair chance, will take a series of important steps to prepare the way for restored health of the part.

An important feature of inflammation is the escape of the white blood cells from the increased quantity of blood that collects at any injured area. It has been mentioned that they approach the walls of the capillaries and actually pass through the walls. They are drawn out by a species of chemical attraction. Their passing out is called diapedesis. In the injured tissues they engulf tissue cells that have been destroyed, and bacteria that may be present. They are called phagocytes when they are performing this function. Their activity is of the same sort whether there are bacteria for them to deal with or not, but it is greater in degree if there are bacteria present.

After engulfing objectionable material and destroying it chemically within themselves, the leucocytes die, and are themselves carried away chiefly in the lymph from the part. If there is a virulent infection they may be carried away while yet alive, and before the bacteria have been destroyed. Phagocytosis does not invariably prevent the spread of infection to the rest of the body.

The red blood cells escape from the capillaries too, especially if the vessel walls have been injured, but they seem to serve no particular function in an inflamed area. Fibrin from the plasma of the blood has, however, almost as important a function as the white cells. It binds together the tissues just outside the inflammatory area, and in this way builds up a barrier which prevents local spreading. This is particularly valuable when the injuring agent is bacterial, for the bacteria are thus walled off. It is thus that many infections, notably tuberculosis, are kept within narrow limits in the body. Islands of bacteria may still be present, but causing no trouble while the healthy tissue about them maintains its defensive function. A loss of local resistance would, however, permit inflammation to extend.

Fig. 145.—Ameboid motion of leucocytes. (Brubaker.)

Inflammation may be classified as acute and chronic. The former comes on suddenly, excites considerable reaction and subsides promptly. The latter is usually slower in onset, slower in progress and leads to delay in healing.

Acute inflammations and even some chronic ones are likely to be accompanied by fever. Fever is most often due to the circulation in the blood of poisons that are formed where injury takes place, for there is likely to be some absorption of harmful materials from any inflamed areas. Fever is to be thought of as a defensive process in inflammation, for it makes the blood more fluid and easier for the heart to pump to the injured area; it makes the heart beat faster for the same purpose, and also to get rid of body waste more rapidly; it makes the respiration faster so that oxygenation is speeded up. Fever usually indicates an inflammatory process going on somewhere in the body. Even a burn or a broken leg is likely to give some rise in temperature, although bacterial activity is its chief source.

In many inflammations, the application of heat over the injured area aids the body in supplying the additional blood, and at the same time it prevents too great passive congestion due to slow outgo of blood. In this way it relieves pain while not interfering with the natural hyperemia. Cold, however, limits the blood supply, and in this way may also give relief of pain, and check a too active inflammatory response. In most circumstances, heat activates the inflammatory process and brings about more speedy repair, but in some instances, it is desirable to check its activity by the use of cold.

The conclusion of an inflammation may be its subsidence by absorption into the vessels of the finally harmless inflammatory products in the tissues; or the discharge of the exudate through a surface, either skin or mucous or serous membrane. The discharge of the exudate may be accomplished either spontaneously—as in a cold; or it may be by means of an incision made for the purpose into a collection of fluid—as in a boil.

In come cases, the inflammation continues for a long period without subsiding. It is then called a chronic inflammation. Chronic inflammations are hard to heal, and while they continue they are always likely to be the source of absorption of poisons that interfere with health.

Typical examples of acute inflammation are those already mentioned—"colds" and boils. The latter usually have to

be opened and drained of their exudate, whereas the former subside finally, after a period of discharge from the mucous membranes, by absorption of inflammatory products, and the shrinking of the respiratory mucous membranes to normal.

Chronic inflammation may, however, follow acute inflammation of any tissue. This is partly because of the persistence of the original cause, and partly because of lack of local resistance in the tissues, or lack of other sorts of body resistance. There is a tendency in tissue to become less resistant after it has repeatedly been damaged even slightly. Each time it is damaged, there is less complete repair, and finally new damage fails to attain even partial repair. Very many individuals have some sort of chronic inflammation—as, for example, in the tonsils.

It should also be noted that chronic inflammation, that is usually a slow, low grade process, may take on sudden, acute activity if for any reason resistance becomes lowered. A chronic inflamed tonsil may, and in fact is likely to, become the seat of an active infection at any time.

The inflammatory process, even in chronic inflammation, represents an effort on the part of the tissues at making the damage less, and at making repair more possible. Inflammation is not in itself reparative, but it leads to conditions that tend, other things being equal, to be followed by repair.

Special mention should be made of the type of inflammation in which bacteria are involved. Although not all bacteria excite inflammation, a large number of them do. These bacteria produce an exudate that is called purulent, the material being called pus, and the whole process being called suppuration. The bacteria that cause pus formation are called the pyogens. Much of the serious disease of man is due to the pyogenic organisms.

The inflammatory process that produces a purulent exudate is the same as that involved in the production of any other exudate. There is an increase in blood supply, slowing of the current, diapedesis of white cells and the process of phagocytosis. Bacteria produce harmful substances that have an especially great attraction for white cells, causing them to appear in very large numbers at an infected area. The white

cells proceed to set free in the inflamed area substances which affect the bacteria and cause many of them to die. They also engulf many of them, alive or dead.

The white cells are not, however, the only elements of the blood that act on bacteria. In the blood plasma there are also substances (anti-bodies) that have a chemical action on bacteria. These anti-bodies have originated as a result of some former infection by the same bacteria, and from that time on have circulated in the blood. Thenceforth they act chemically in such a way as to neutralise the poisons from new bacteria of the same sort. In addition, more anti-bodies are also produced at the time of new infection, or, if none are already present, some will usually be produced at the time of infection. The white cells without the assistance of the anti-bodies in the plasma could not succeed in coping with infection. The body must have the specific ability to neutralise the poison of specific bacteria, as will be explained in the chapter on immunity.

The best illustration of purulent inflammation is seen in the boil. The boil has been referred to as typical of acute inflammation. It may also be mentioned as typical of purulent inflammation. It shows all the classical signs of inflammation —rubor, tumor, calor and dolor. Soon there appears in the center of the boil the material called pus, which consists of liquefied tissue cells, living or dead bacteria and white cells, and fluid from the blood. Pus is usually yellowish or greenish because many of the common pyogens produce these colors. The usual outcome is that the skin over the surface of the center of the boil becomes thinned by pressure of the material underneath it, the skin ruptures and the pus escapes. Or the skin may be incised to let the pus out. While this process has been going on, the white cells have been very active, many of them have been destroyed in performing their function of phagocytosis, and many new ones have been formed in the cell-forming parts of the body, and set free in the blood, to travel to the infected area.

If the blood is examined during abscess formation, it will be found to contain more white cells than usual (leucocytosis). If the purulent inflammation is going on in the hidden parts of

the body, such as the appendix, the examination of the blood for an increased number of white cells is sometimes of great value, indicating as it does that there is somewhere a need for more white cells than usual. Leucocytosis is due to the stimulation, by the poisons circulating in the blood, of the structures that form white cells. It is easy to see why a tender spot in the region of the appendix, coupled with a rise of temperature and an increase of white cells should lead to the suspicion of trouble. It is also easy to see why an effort is made to check the inflammation by the use of cold, if the inflammation is mild; and why an immediate operation is called for if there seems to be danger of the appendix abscess rupturing and discharging its infected contents throughout the abdominal cavity.

Purulent infection may occur on flat surfaces of the body, such as the lining of the respiratory tract, as in the second stage of a cold; or it may occur in the cavities of the body, such as the bladder or uterus; or in the substance of the more solid organs, such as the lymph nodes or the glands.

After any inflammatory process, the next step is the absorption of what remains of the exudate and the destroyed portions of the tissues. This must take place before healing begins. It is called the process of resolution. It begins, if the body is able to cope with the injuring agent, about as soon as the inflammation itself. By the time the inflammation has subsided, there will ordinarily be little left to be absorbed. The duration of the inflammation and of the resolution depends on the amount and severity of the damage done. After some infections—as, for example, the infection of the lungs called pneumonia—there must be a long period of convalescence, in order to permit complete absorption of a considerable amount of exudate remaining in the tissues. Following soon after resolution, comes the remarkable process of repair or healing, by which the tissues are restored to their working power in a large proportion of cases.

b. Repair

Regeneration of tissue consists, first, of the restoration of the circulation in the part, if it has been interrupted by the

rupturing of capillaries, and then of the regrowth of cells that have been damaged.

The simplest sort of repair or healing is that which takes place by "first intention." This is seen best in a cut. If no bacteria enters the cut, and the edges come neatly together, new cells form to unite the severed capillaries and to fill in the spaces between the other tissue cells. Union is in such a case very prompt. There will not be any of the phenomena of inflammation.

A more complicated process takes place when the damage has produced inflammation, and healing must follow the inflammatory process. When tissue has been destroyed, or when an irritant is present, or when bacteria are present, inflammation results, and healing is said to take place by "second intention." It should be noted that the repair process is the same whether bacteria are present or not, although bacteria tend to make the process more difficult and longer.

Young tissue and that which normally has a good supply of blood tends to repair more rapidly than older tissue or that which lacks a good blood supply. Healing is also more rapid and more complete in the lower types of tissue than in the more specialized varieties, such as nerve tissue. It is also better in lower animals than in man. The lobster can grow a whole new claw if necessary. The worm, if cut in two transversely, becomes two worms, each half having developed an entire half of the body.

Repair by second intention (that occurring after inflammation) involves first a growth of many new blood vessels. This occurs by budding from the capillaries at the lower part of the injured area. It is notable that the blood supply for newly forming tissue, its source of nutriment, is formed before the tissue itself is formed. Along the small new capillaries grow cells of fibrous tissue, filling in the space from below up. Finally the surface is covered over with its original tegumentary tissue. Skin wounds will be re-covered with skin if damage to it is not too extensive. If the damage is great, only fibrous tissue replaces the epithelium, and a scar is present to mark the place where repair occurred. Even if no surface of the body is injured, there will be cells to be replaced after any

inflammation, and the process always takes place in the way mentioned.

In some parts of the body, repair results in the restoration of the original cells of the part. In others, only fibrous tissue cells are formed. Although the appearance of a scar on the skin is familiar, it should be noted that similar dense, fibrous tissue may arise even in the interior of the body to replace the tissues lost in an inflammatory process. It is the replacement of the proper cells of a part by scar tissue that constitutes much of the disease of the internal organs, for fibrous tissue is not a perfect substitute for many of the important cells with highly specialized functions.

The degree to which scar tissue interferes with function depends on the amount of it that has to be formed to replace the natural cells of the part, and on the function of those cells. A small scar in the skin may not interfere with any function. In a large muscle a small amount of scar tissue may not seriously interfere with its motion, whereas in a small muscle, any amount of scar tissue might be hampering. In the transparent cornea of the eye, any amount of opaque scar tissue would be likely to prevent vision through it, rendering the repaired cornea of no use. The same is true in principle of the repaired ear drum, which may not vibrate to sound as well as the original tissue did. In nerve and brain cells, fibrous repair tissue is detrimental because it does not conduct nerve impulses as the original cells did.

Tissues that serve their function well after repair are the skin, the blood vessels and most of the connective tissues, including bone. Cartilage shows little tendency to repair, which is one reason for the seriousness of joint infections. Muscle does not repair by the production of new muscle cells, although, as has been mentioned, the results may not be serious. In the brain there is no repair by new brain cells. Any destruction of brain cells is therefore to some degree, often to a great degree, permanently damaging. In the lung, however, the epithelium lining the air sacs often repairs completely.

Fibrous tissue, it will be seen, is not quite as satisfactory as the tissue it replaces, in most cases. It represents the best

that nature can do to render the body intact again, but it is often not very successful.

Scar tissue has a marked tendency to contract, or to fill up less space than the original tissue, and to continue to contract

Fig. 146.—Unreduced fracture, showing repair by deposit of bony tissue about both ends. Ten weeks after fracture. (Courtesy of Dr. M. E. Cooney.)

for some time after it is formed. It is for this reason in particular that in some parts of the body repaired tissue is not so satisfactory as the original. In the case of damage to the valves of the heart, although repair may be complete, scar tissue causes them to be less adequate as valves, in that they

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may be unable to completely close the aperture after the blood has passed through. This gives a "leaky" heart. Repair that involves ducts of any sort often results in a degree of circular contraction of the duct sufficient to prevent secretions from passing through freely. This is called stricture. It may occur in the ducts that carry the ova and the spermatozoa, giving sterility because these cells cannot pass out for fertilization.

The most satisfactory kind of repair occurs after fracture (break) of a bone. If the two ends are brought together by "setting" the fracture, and are held there for a sufficiently long time in either splints or plaster, new bone grows across the gap, and the bone is as strong as before. An X-ray photograph of such a bone shows, at the repaired area, a thick ridge of bone, for even more bone is formed than is actually needed.

Generally speaking, most injuries are repaired somehow, to some degree, but not all repair gives as good function of the part afterward as was possible for the organ before injury. As has been said, repeated injury or infection reduces the ability of a part to repair. The whole process depends for its success on the part involved, the activity of the blood supply and to a considerable degree on the general health of the individual. Although the ability to repair itself is intrinsic in the body, it often fails of complete success because the body is not suitably aided in its efforts. Physicians have so emphasized, in recent years, the self-healing ability of the body, that laymen sometimes place too great reliance on it, and neglect measures that would facilitate the process and make it more certain and complete.

CHAPTER XX

INFECTION

The problem of maintaining the healthy functioning of the tissues and organs of the body would be vastly simpler were it not for the fact that man is subject to invasion by microscopic living organisms that are capable of producing changes in his tissues to such an extent that they are locally damaged and his whole system perhaps affected by the toxins or poisons there produced.

FIG. 147.—Various bacteria. (MacNeal.)

The term parasite is used to describe any form of living body that conducts its life processes on another living body and at its expense. The most injurious parasites on man are the pathogenic micro-organisms, so called because they are living organisms of microscopic size, capable of producing disease.

The vast proportion of the parasites on man are the bacteria, otherwise known as microbes or germs. Of all causes of illness no one cause is comparable to infection by bacteria. A large part of hygiene, and of medical science as a whole, is concerned with efforts to prevent and to combat bacterial activity.

There are countless billions of bacteria in the world, but not all of them are pathogenic (disease-producing) for man.

Interesting as the consideration of the non-pathogenic bacteria is, it must be omitted here, except to refer to the fact that the activities of the non-pathogens in getting their nourishment is often such that chemical changes that are most essential to human welfare are produced in the material on which they live. These bacteria are not only not injurious, but are sometimes positively beneficial, and in some cases fundamentally necessary.

Chief among these are the bacteria in the soil, that convert all protein substances that are deposited in the soil into nitrates, that supply nourishment for plant life. Without these bacteria the world would soon become unbearable because of the accumulation of dead organic material, such as leaves and plants and trees and animals. Furthermore there would be no new vegetation growing up, and consequently no new animal life, because of the lack of vegetation that nourishes animals. Man himself could not survive.

Less important but equally harmless are some of the bacteria that make changes in food substances, rendering them more palatable. The flavor of the various kinds of cheese, for example, is determined by non-pathogenic bacteria that grow in them, and in fact are implanted for this very purpose in the milk from which the cheese is made.

Of those bacteria that are pathogenic, some produce disease in man and not in animals, and some are pathogenic for certain animals and not for man. It is in those that are pathogenic for man that science is naturally most interested, although the diseases of animals have always attracted much attention, for economic reasons and also because some of the diseases of animals are communicable to man.

The history of the study of bacteria is not a long one. All of the study that is of any present value dates back only to the middle of the last century. Before then the existence of bacteria was suspected, and some shrewd guesses were made regarding the communicability of disease. Illness was observed to follow contact with persons who were ill and with their discharges, which naturally led to the suspicion that some agent of disease passed from one individual to the other. It was not until the 19th century, however, that bacteria were recognized as such, and their relationship to disease demonstrated. Pasteur and Koch were the two scientists whose work laid the foundation of bacteriology.

All bacteria are single cells. In size they are all less than $1/2000$ of an inch long. The tubercle bacillus is $1/50,000$ of an inch in diameter. In form bacteria are either cocci, bacilli or spirilla. A coccus is spherical; a bacillus, rod-shaped; and a spirillum, spiral in shape. Some of the cocci always appear

in pairs, and are called diplococci. Some of the bacilli occur in chains. Bacteria are identified by the examination under the microscope of material which has been stained in such a way as to show the bacteria in contrast to the secretion or excretion in which they are found.

Bacteria carry on all processes of living as single cells, including respiration, nutrition, excretion and reproduction. As a rule they have no power of motion, but are passively carried about in the fluids of the body, escaping from the body with

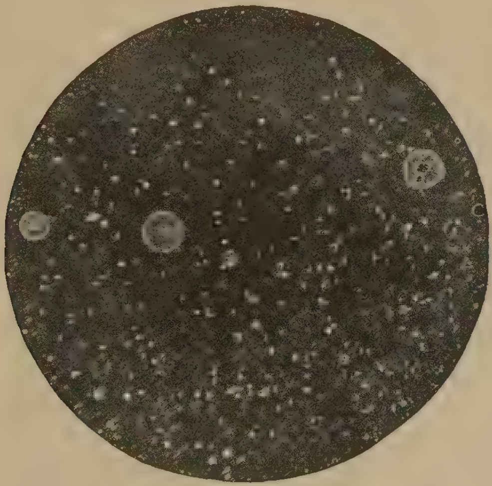

Fig. 148.—Gelatine plate on which colonies of bacteria have grown. (MacNeal.)

its excretions and secretions and in the exudate from infected parts.

Bacteria cannot live and reproduce unless conditions are favorable about them. The warmth and moisture of the human body is usually favorable for a large number of different varieties, which, however, die quickly when they are exposed to other conditions.

It is by the process of nourishing themselves that bacteria injure the tissues of man. In order to prepare their nutriment they secrete ferments theoretically similar to the digestive enzymes man produces to prepare his food for digestion. These ferments decompose the substance on which the

bacteria are living. They are thereby nourished, and they then give off waste products. These local chemical changes are damaging to the cells of the part of the body involved. Many of them die. Also many of the bacteria die, and in their dissolution give off all of the toxic material they contain. The chemical changes produced when bacteria are present are thus the result of the interaction between the bacteria—conducting their normal life processes—and the body cells which are destroyed thereby.

It should be noted that most bacteria produce local damage at the point where they enter the body. In the case of some, however, the local damage is at a minimum, and the greater part of the harm is done as the toxins, even perhaps the bacteria themselves, get into the circulation and travel to other parts of the body. The amount of general damage done varies with the degree and virulence of the infection. There is some general disturbance, however, from most infections, and often interference with functions, if not structural damage, elsewhere than in the primary lesion.

The local changes that are produced are of several different sorts. Foremost among them may be mentioned the inflammatory process, which has been discussed in Chapter XIX. A very large proportion of inflammation is ultimately, if not at first, due to bacteria.

Not all bacteria that produce inflammation produce a purulent exudate. Those that do so are called pyogens or pus-producers. These constitute the most common varieties of pathogens. Those bacteria that do not cause typical inflammation with pus formation often cause other changes in cells locally, and often produce toxins that circulate—thereby causing as much damage as do the pyogens.

Bacteria gain entrance into the body through the skin, and by any of the natural openings into the body. It is probable that more bacteria enter by the mouth and nose than by any other single route. Food and water and milk are the vehicles for many, whereas droplets sprayed out by infected persons in coughing and sneezing are the vehicle for a still larger number.

The hands carry many bacteria into the body. On them are always large numbers of bacteria, because they inevitably

handle all sorts of objects, some of them having fresh bacteria on them. If the hands while thus contaminated come into contact with the easily infected mucous surfaces of the body, infection is most likely. The use of contaminated articles in common with an infected person is also a frequent source of infection, especially among those to whom all toilet articles except tooth-brushes are considered common property. Direct contact with the ill—by means of hand-shaking, kissing and so forth—is of course the most likely of all ways of acquiring infection. The original source of most infections is the infected human person, his secretions and excretions, with which one may come in contact in many indirect ways also, as by the taking of infected food, milk or water, or through handling of articles recently contaminated by bacteria.

There are some pathogens that live in man's body constantly and are relatively non-pathogenic until something arouses them to greater activity. They are found in the mouth, on the skin and in the intestinal tract. The conditions that lead to infection by habitually present bacteria are usually local changes, such as congestion of the throat, which results in more secretion that may give bacteria an advantage. In the skin, a cut may allow the bacteria in the mouths of the sebaceous ducts to gain access to the epithelial tissue from which they are ordinarily excluded by the wall of the duct. Even the duct itself is sometimes infected.

It is also true that general states of the body may change local resistance in such a way as to permit the resident bacteria to gain the advantage over the tissues. Any of the causes of lowered general resistance—such as fatigue, malnutrition, and exposure—may lower local resistance.

A normal bacterial inhabitant of one part of the body may be a serious menace in other parts of the body. For example, the colon bacilli, that are always present in the intestinal tract, seldom do harm there. But if such bacteria ascend along the alimentary canal and enter the ducts of the gall bladder or the pancreas, serious disease is produced. Intestinal bacteria often cause inflammation of the appendix.

Old chronic infected tonsils may never be the site of acute inflammation; yet they may be responsible for serious infec-

tion in the joints or in the heart. Even if infected tonsils appear to give no trouble their removal is usually advised, because of the likelihood of their producing insidious trouble elsewhere.

Bacteria vary in virulence. Some are capable of producing violent reactions as soon as they enter the body; others are relatively inert. But the same bacteria that are harmless for

FIG. 149.—Tubercle bacilli as found in sputum in tuberculosis. (MacNeal.)

one individual may be virulent for another, whose condition is more favorable for their growth.

There is usually a period of incubation after bacteria enter the body and before disease appears. During that time the bacteria are multiplying. The pyogenic bacteria usually start their activity almost at once. When there is an incubation period it varies in length according to the disease. Ordinarily

during this period the disease is not communicable, although many diseases are particularly communicable in the few days before their symptoms appear. It is this fact that makes many of the acute infectious diseases difficult to prevent from spreading.

All bacteria are localized, at least for a time, at the point where they enter the body. Some remain so, but give off toxins that are absorbed by the blood and cause systemic symptoms. In other cases both the bacteria and their toxins circulate. The bacteria may implant themselves elsewhere in

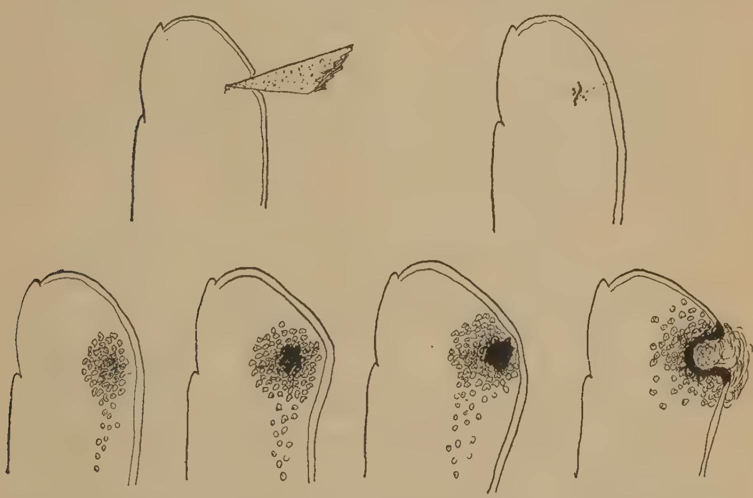

FIG. 150.—Superficial infection from the time of entrance of bacteria-bearing object into the finger, to the discharge of pus.

the body, and produce there the same sort of lesions as the original ones.

Infection spreads in three different ways. First, it may spread by continuity of tissue—as when a cold travels along the mucous membrane of the nose to the throat, larynx and lungs. Second, it may spread by means of the blood stream, the infective material having been taken up into the capillaries in the infected area. Third, it may spread by the lymph vessels from the original source, ultimately to be arrested at the lymph nodes, or to pass into the general circulation.

It should be noted that the original infection, from which spreading takes place, may appear insignificant or be inconspicuous. It is for this reason that slight acute infections should be treated promptly, and that even slight chronic infection should be cleared up if possible. Many forms of illness, otherwise inexplicable, have been traced to what is called a focus of infection. The most common foci are infected tonsils. Second to them in frequency are abscesses at the roots of teeth. The vermiform appendix and the gall bladder are also common seats of infection.

Although bacteria are very prominent in the causation of disease they are not by any means invariably uncontrollable. The part the individual organism plays in relation to infection is as important as the part played by the bacteria. It is possible to conduct one's life so as to minimise both the danger of infection, and also the serious results of infection, should bacteria start activity in the body.

The Communicable Diseases

There are many diseases that are called transmissible or communicable because they are readily passed from an infected individual to others, producing in them the same disease. Not all diseases produced by bacteria are communicable as such. In some diseases the bacteria released from an infected individual may cause in another a different type of disease. In other bacterial diseases the bacteria are not so located as to have free exit from the body—as for example in appendicitis. Those diseases that are classified as communicable appear in similar form in all those who take the disease, although in one the disease may show more symptoms and be more serious than in another.

The communicable diseases are so readily communicable that many of them tend to be acquired early in life, and have thus come to be considered as children's diseases. If they are not acquired early they may, however, be acquired at any time when exposure to them is sufficiently great. Although many of them are not in themselves particularly serious, almost all of them may lead to grave complications. The lasting ill health

due to the complications of scarlet fever, for example, makes it one of the serious disease problems. The death rate from so lightly considered a disease as measles is very high. Because these diseases are so common there is a tendency not to take them seriously, which is most unfortunate. Public health experts believe that the prevention of all of the communicable diseases is important, and that in the case of some of them prevention is of the utmost importance.

Regulations regarding communicable disease include the reporting of all cases of such disease to boards of health, and the isolation of the sick. It also includes measures for the observation, and sometimes also the isolation, of "contacts," i.e. those who have been exposed to them. The reason for isolation is plain. The reason for observation of contacts is that the earliest signs of the beginning of the disease may be noted, and the individual isolated in time to prevent his spreading the infection. Unfortunately many of the communicable diseases may be given to others before the characteristic, well-recognized symptoms of the disease appear (e.g. the rash, in measles). It is therefore necessary that following exposure expert observation should be had, in order that symptoms of the beginning of infection be detected at a time when the layman would be unable to detect them.

In colleges it is usually required that exposure to a communicable disease be reqorted, and that the individual place himself under observation during the period when the disease might appear. When many individuals are living in close relation to each other, it is only fair that, for the sake of others, the ill or those who may become ill should sacrifice their personal convenience for the protection of other members of the group. The same principle applies in circumstances involving no known exposure, if suspicious symptoms, or in fact any symptoms of disease, appear in a member of a group. At such times the individual owes it to the group to have medical advice regarding the suitability of his remaining in contact with the group. Because many communicable diseases begin with signs of a common cold, either of the nose, throat or chest, an individual who possesses a social conscience will not be satisfied, when such symptoms appear, to conclude

Communicable Diseases

Disease	Incubation period	Duration of communicability		Means of transmission		Initial symptoms
		Beginning	End	Direct contact with	Indirect contact with	
Chicken-pox	10–21 days	From first symptoms, before rash appears.	When scabs have disappeared and have not re-formed. Usually 3 weeks from appearance of rash. Isolation period 3 weeks or more.	Mouth secretions. Skin.	Articles freshly soiled by discharges from mouth and skin	Rash, appearing within 24 hours. (Rash resembles that of small-pox.) Mild constitutional symptoms.
German Measles	10–21 days	From first symptoms, before rash appears.	When rash is gone and no symptoms present. Isolation period 8 days.	Mouth and nose secretions.	Articles freshly soiled by discharges from mouth and nose.	Mild constitutional symptoms often for three or four days preceding rash Eyes congested. Glands in neck enlarged. Often begins like a "cold." Rash usually appears on second day.
Measles	7–18 days (usually 14)	From first symptoms, before rash appears.	When there are no abnormal secretions. Isolation period 14 days.	Mouth and nose secretions.	Articles freshly soiled by discharges from mouth and nose.	Constitutional symptoms, with fever, often one or two days before onset. Rash preceded by catarrhal symptoms in eyes and nose, resembling a "cold." Cough, often. Glands in neck enlarged. Rash appears on fourth day.

Scarlet Fever	2–7 days (usually 3–4)	From first symptoms, before rash appears.	When no "peeling," discharges or abnormal secretions. Isolation period 4 weeks or more.	Secretions or discharges from mouth, nose, throat and other lesions, if any.	Articles recently soiled by discharges from mouth, nose, throat and other lesions. Peeling skin not infective unless contaminated with discharges.	Before rash appears, fever, headache, vomiting, chills, sorethroat. Rash appears second day. (The sorethroat may suggest a severe "cold.")
Mumps	14–25 days (usually 18)	A short time before swelling appears, from mouth and possibly nose secretions.	When salivary glands normal. Isolation period 3 weeks or more.	Secretions from mouth and possibly nose.	Articles freshly soiled by discharges from mouth and possibly nose	Salivary glands enlarged, in front of ear and under lower jaw. (May suggest swelling due to teeth.)
Diphtheria	2–7 days (usually 2)	Occasionally organisms carried in nose or throat before symptoms appear. Usually communicability begins with earliest symptoms.	When no diptheria bacilli in secretions or lesions. Three successive negative cultures required.	Secretions or discharges from mouth, nose, throat and other lesions, if any.	Articles freshly soiled by discharges from mouth, nose, throat or other lesions.	Inflammation of throat and often of nose. Fever and constitutional symptoms. (Symptoms often suggest a "cold.")
Septic Sore-throat	1–3 days	From earliest symptoms.	When throat normal and patient well.	Throat and possibly nose secretions.	Articles freshly soiled by discharges from throat and possibly nose.	Sore throat, fever, prostration, enlarged glands in neck. (The sore-throat may suggest a severe "cold.")
Whooping-cough	10–14 days (usually 10)	2 weeks or more before whoop appears, from throat or bronchial secretions.	Usually 4 weeks after catarrhal symptoms appear, and 2 weeks after whoop appears.	Throat and bronchial secretions or discharges	Articles freshly soiled by throat and bronchial discharges.	Catarrhal inflammation of respiratory tract, like a "cold." Fever. Cough, which is severe but does not become whooping until later.

Fig. 151.—Chart on communicable diseases.

COMMUNICABLE DISEASES.—(*Continued*)

Disease	Incubation period	Duration of communicability		Means of transmission		Initial symptoms
		Beginning	End	Direct contact with	Indirect contact with	
Influenza	1–4 days	From earliest symptoms.	When there are no discharges or abnormal secretions, and patient well. No stated isolation period.	Secretions or discharges from nose, mouth, throat and bronchi.	Articles freshly soiled by discharges from nose, mouth, throat and bronchi.	Prostration, general aching, fever, headache. Sometimes sore-throat and cough. Resembles severe "cold."
Pneumonia	2–3 days	From earliest symptoms.	When there are no discharges or abnormal secretions, and patient well. No stated isolation period.	Secretions or discharges from any part of respiratory tract.	Articles freshly soiled by discharges from any part of respiratory tract.	Fever, chills, cough, pain in chest. May have been preceded by a "cold."
Smallpox	12–21 days (usually 12)	About 3 days before rash appears.	When all scabs have disappeared.	Skin, mucous membranes, and any body secretion or discharge.	Articles freshly soiled by discharges from the body. Skin lesions infective.	Fever, chill, genera pains, headache, vomiting. Rash appears on fourth day.
Typhoid Fever	7–23 days (usually 10–14)	From earliest symptoms, before frank illness is present	When no bacilli present in discharges, and all lesions healed.	Intestinal excreta, urine and discharge from any lesions.	Articles freshly soiled by discharges, especially those from the intestinal tract. Infected food, water or milk.	Fever, headache, nosebleed, intestinal symptoms. Very slight rash, often.
Tuberculosis	Weeks, months or years after entrance of bacteria	Frequently before significance of symptoms is suspected, and disease	When no bacilli in discharges. When sputum no longer produced, in case of	Discharges containing bacteria.	Articles freshly soiled by discharges containing bacteria. Infected milk.	Various symptoms according to location of disease. Lung tuberculosis: loss of weight,

		diagnosed.	lung tuberculosis.	(Danger of contagion children than in adul	much more serious in ts.)	cough or expectoration, weakness, afternoon rise of temperature; digestive disturbances. There is a slight failure of health in most cases before most of these symptoms appear.
Cerebro-spinal Meningitis	2–10 days (usually 7)	Sometimes after bacteria are received and before symptoms appear. Usually from onset of symptoms.	When no bacteria in nose and mouth secretions and patient is well.	Secretions or discharges from nose or throat.	Articles freshly soiled by discharges from nose or throat.	Severe headache, fever, prostration. May have slight rash.
Con-junctivitis	36-48 hours	From first symptoms.	When no discharge from eyes.	Discharge from eyes.	Articles freshly soiled by discharge from eyes.	Redness, swelling and discharge from eyes. Resembles results of irritation, or of a "cold." Early signs similar to those of measles and German measles.
Syphilis	3 weeks	May be communicable in the absence of recognizable symptoms	When no open lesions on skin or mucous membranes and no organisms demonstrable in blood. (Wasserman test).	Discharges from any open lesion.	Articles freshly soiled by discharges from any open lesions.	First stage: chancre. Second stage: lesions of skin and mucous membrane, and numerous other symptoms.
Gonorrhoa	1–8 days.	May be communicable in the absence of recognizable symptoms.	When no discharges and no bacilli demonstrable in normal secretions	Discharges from infected areas.	Articles freshly soiled by discharges from infected areas.	Discharge from infected area.

FIG. 151.—Chart on communicable diseases.—(*Continued.*)

that he is a safe member of society, but will seek medical confirmation of the fact. It is only by the most meticulous attention to these principles that epidemics of communicable disease will ever be prevented from arising in groups. Where enlightened systems of reporting exist, and are faithfully conformed to by each member of the group, the whole group is in a much safer position.

It is to be expected that students in colleges should be able to appreciate the significance of regulations regarding their behavior with respect to communicable disease, and should hold themselves and their associates to a high standard in the observance of such regulations. Popular opinion should be such as to make infraction of such group-protective regulations a serious offense. If a student escapes acquiring the knowledge of the significance of the regulations, his ignorance hardly excuses him for being the cause of illness among his associates.

Certain information regarding some of the more common communicable diseases will be found in the accompanying chart.

There are two very serious communicable diseases that require separate consideration, since there is less popular knowledge of them than of some others. It is partly because of this lack of information about them that they are so common. They are called venereal diseases because they are acquired chiefly through sex relationships, or venereal contact. (The term venereal is an ancient one, derived from Venus, the name of the Greek goddess of love.)

These diseases are kept present in communities because of the existence of women who permit sex relationships for pay. Prostitutes quite early in their career acquire gonorrhoea or syphilis, or both diseases, from patrons who are infected. Thereafter the infected prostitutes serve as the distributing center for these diseases to those who visit them, and through them to others.

Syphilis is probably present in about three per cent of the population, and indirectly or directly is responsible for a large amount of sickness and for many deaths. It is an old disease, having been introduced into Europe from Haiti in 1494 by the sailors of Columbus' party. It became very widespread at that time, and is now found all over the world.

It is caused by an organism called the spirocheta pallida, first seen in 1905. The following year Wasserman discovered the chief test that is used to demonstrate the existence of the infection. Four years later the present form of successful treatment by an arsenical preparation known as "606"

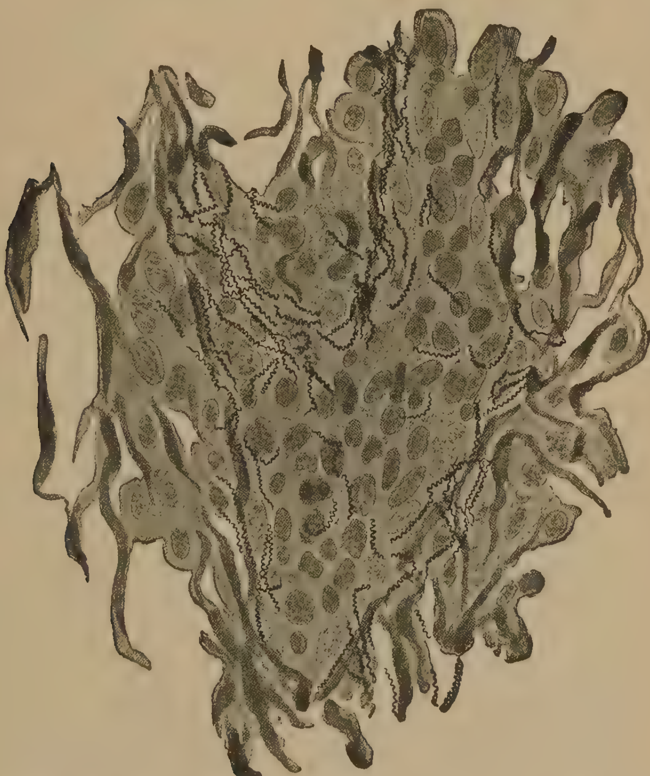

FIG. 152.—Spirocheta pallida, as found in tissue cells in syphilis. (MacNeal.)

(because it was Ehrlich's 606th experimental preparation) was discovered.

The organism enters the body chiefly through the genital tract in sex intercourse. On the mucous membrane it produces a sore, called a chancre, which may be quite small but ordinarily somewhat resembles a "cold sore." This passes away in time, usually in three or four weeks, the organisms

meanwhile having gotten into the blood in large numbers. A second stage of the disease follows, after an interval, in which a variety of symptoms appear—chiefly lesions on the skin and the mucous membranes. Sometimes the general health is quite impaired. This stage often lasts a number of months.

During both of these stages the disease is easily communicated to others—at first only from the primary sore, but in the second stage from whatever lesions are present. If there are lesions in the mouth, infection may be distributed thence.

Aside from genital contact, and oral contact, as in kissing, there is some danger of infection through the use of infected articles in common with an infected person. It is chiefly those articles such as towels, dishes and toilet articles that come into intimate contact with the infected individual, and within a short time with an uninfected one, that are most dangerous. One should not have too great fear of accidental contagion. If ordinary hygienic precautions against any communicable disease are taken, one will at the same time be taking measures to avoid this disease. There are relatively very few cases of syphilis that are not due to direct personal contact. As is the case in respect to other infections, it is possible for an infected individual not to realize that he is so, and to infect others quite inadvertently.

Those who learn that syphilis causes skin eruptions are rather prone to suspect syphilis in all skin diseases. Such conclusions are usually unwarranted when made by others than physicians, who use many tests other than inspection to reach their conclusions. Many individuals with harmless acne have been made more unhappy than their appearance makes them by having unfounded suspicion attached to them.

Syphilis would be a serious disease if it did no more than what has been described. But there is unfortunately a third stage of the disease in which the organisms have established themselves in the various organs of the body, causing destructive changes. This stage comes on sometimes as much as several years after the second stage. The bones, joints, heart, blood vessels, liver, brain, spinal cord, in fact any part of the body, may be attacked. During this stage the organisms are

in the blood and the organs, and although the individual's life is in danger, he is not a menace to others. Death or permanent invalidism is likely to be the outcome of this stage. It is in the latter part of it that the nervous system is most susceptible. Two very serious diseases, one of which includes insanity, and both of which include paralysis, may be the end result.

Since 1909 it has been known that if the disease is diagnosed early enough, and treatment is begun early enough and continued long enough, the disease is curable. It is now a reportable communicable disease in most states—the State having an interest in seeing that cases receive the treatment they need.

Unless cure has been thoroughly established, the individual who has had syphilis may not marry without danger of transmitting the disease to the mate and the children. It usually takes at least three years to be sure of this. If the disease is still active at marriage it is likely either that no children will be born alive, or that they will be born defective—perhaps of feeble mentality, deformed, blind or deaf.

The prevention of syphilis is chiefly by the avoidance of promiscuous sex relationships. No individual who runs the risk of infection expects to be infected, but there is no way of protecting one's self entirely against such danger. Neither is it safe to rely too much on cure, for it is not uncommon to have the first and second stages so inconspicuous as not to be noticed, and the first indication of the disease to be the symptoms of the third stage, at which time cure is not possible.

Gonorrhoea is a still more widespread disease than syphilis, and in the aggregate perhaps causes almost as much serious trouble, although it is popularly considered as rather insignificant.

The organism that causes it is one of the pus-producing variety. Its typical symptom in either sex is a thick, yellowish discharge from the genital tract. It is usually contracted as a result of sex relationships with an infected individual, but may be contracted by the use of articles in common with the infected. What has been said of the prevention of syphilis contracted in this way applies to gonorrhoea also.

There is a spontaneous partial recovery from gonorrhoea after a few weeks—that is, the discharge stops, even without treatment. But unless treatment is thorough the bacteria continue living in the more deeply situated parts of the reproductive tract. In the male the prostate gland is often infected, and from there the organisms may emerge later and cause infection of others during intercourse. It is usually possible to determine before marriage whether a former infection has entirely subsided, or whether bacteria are still harbored.

In the female the bacteria often travel to the Fallopian tubes and ovaries, and there may cause either an acute inflammation

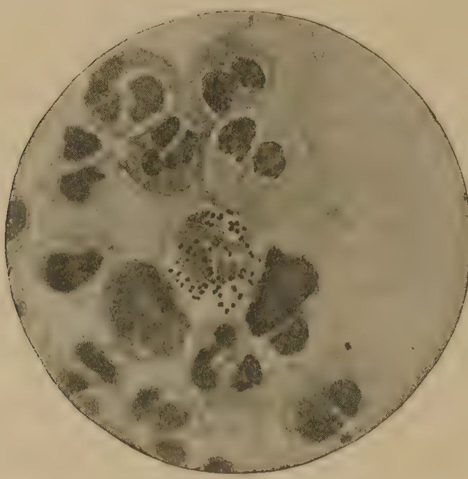

Fig. 153.—Gonococci in pus cells, as found in the discharge of gonorrhoea. (MacNeal.)

that requires an immediate operation, or a protracted inflammatory condition that causes partial invalidism. Frequently an operation for the removal of the reproductive organs is later necessary.

One of the common results of gonorrhoea in either sex is the stricture (closing) of the ducts that carry the reproductive cells outward. Since the cells are sealed in, no fertilization can take place. Sterility may thus be due to a former gonorrhoeal infection in either sex.

Sometimes the organisms of gonorrhoea travel over the body and cause disease in the heart or in the joints, just as may

other pyogens. This may occur during the acute stage, or from a chronic focus of gonorrhoeal infection in the reproductive organs.

The individual who is infected may carry the bacteria on the hands to the eyes. The mucous membrane of the eye is particularly susceptible. Especially is this true of the eyes of the new-born child, into which the bacteria may be swept as the child passes through the infected birth canal of the mother. There are laws requiring the use of silver nitrate in the eyes of all new-born babies, whether infection of the mother is suspected or not, to prevent what was formerly a common cause of blindness.

A discharge of whitish material from the vagina (leucorrhoea) should not be confused with the discharge of gonorrhoea. The former is often not the product of bacteria at all, but merely an oversecretion of the mucous membrane. Such a discharge is fairly common, especially in those who are not very vigorous, are anemic or lead a sedentary life. It is more likely to occur just before the menstrual period. The condition should be investigated, for there is often some habit of living to be changed. It is a result and not a cause of ill health, and is not "weakening"—as the superstition runs.

The venereal diseases represent an epidemiological problem that must be approached from many different angles. Social conditions are among the important factors contributing to perpetuate them. Yet they are fundamentally medical problems, to be dealt with by individuals through the development of habits of physical and mental hygiene.

CHAPTER XXI

RESISTANCE AND IMMUNITY

As has been shown, not all bacteria that get into the body produce disease. There are probably no pathogenic bacteria capable of invariably producing disease in all individuals under all circumstances, when they get into the body.

We have seen that part of the reason for failure of bacteria to infect has to do with the bacteria themselves, their kind, their number and their virulence, and with the route by which they enter the body. Equally important in influencing the degree of infection, however, is the condition of the tissues upon which bacteria arrive. The tissues may be so resistant or non-susceptible to certain bacteria that such bacteria can gain no foothold, or, having established themselves, can do little, if any, harm.

Theobald Smith used the formula $D = \frac{M}{R}$ to indicate the factors that influence the occurrence of disease when bacteria enter the body. Disease (D) is produced in proportion to the relationship between the microbial attack (M) and the vital resistance (R) of the individual. If the microbial attack is severe and resistance low, serious disease is produced. If the microbial attack is light and resistance is high, no disease is produced. Between these two extremes, there are cases in which the two factors nearly balance each other, and disease is perhaps limited to a mild local infection, without constitutional symptoms.

The efforts of hygiene, both personal and public, are directed toward changing the ratio between M and R, so as to minimise the incidence of disease and its severity.

Efforts both of communities and of individuals should be directed toward minimising the M factor—that is, reducing the number of the bacteria that get into the body. These may

be called methods of offensive warfare against bacteria. But in spite of all efforts it is inevitable that some bacteria should be successful in invasion. In order to prevent disease from arising under such circumstances it is necessary to rely upon a strong defense—that is, to increase in individuals the R factor.

Whatever the microbial attack, disease, it should be borne in mind, does not result if resistance is great enough. It is possible to have resistance so great against a given bacteria that no ordinary invasion will produce the slightest result. Furthermore it is possible to develop during the course of a disease a degree of resistance that stops the infection.

The aim of medical treatment is usually not toward killing bacteria when they get into the body, but toward enabling the body to do so, by helping it to increase its resistance. It is not very satisfactory in most cases to attempt to sterilise (i.e. to render free from bacteria) any part of the body except its outermost layer of epidermis. In coping with infectious disease, therefore, the most successful measures are along the line of providing conditions less favorable for bacterial growth and more favorable for the development of both local and general body resistance, and of specific resistance to the special bacteria involved.

At present science knows how to raise resistance in advance against some bacteria, to such a degree that the body is entirely immune to them. In other cases resistance may be increased during an attack of a disease so that it is terminated quickly and favorably. In still other cases, without any special outside assistance the body succeeds in rendering itself immune or relatively non-susceptible. If resistance is not good, and may not be raised, the bacteria triumph, the result depending on the severity of the infection.

It is an everyday observation that many diseases are "self-limited." They do not go on forever, but after having "run their course" they come to an end. Quite apart from any treatment many infectious illnesses are ultimately terminated by a restoration to health, although treatment may aid the restoration, or minimise the discomfort, or make the restoration more complete.

The explanation of the "self-limitation" of disease was not found until the comparatively recent studies of bacteriology. Formerly it was thought that the bacteria died because there was nothing left for their nourishment, and that the infection stopped because there were no longer any bacteria present. It is true that the cessation of infection is due to the reduced number and virulence of the bacteria. But they do not die off; they are killed off. The tissues do not merely passively cease to be a good feeding ground for bacteria. They actively render themselves harmful to the bacteria. The activity of the bacteria would be as great as ever were it not for the superior activities of the tissues of the body. In no sense can the body be considered a pasture for the feeding of bacteria whereon the bacteria die when their fodder is exhausted. One must look upon the developed resistance to disease as an active process on the part of the tissues.

It has been the concern of biology to find out what it is that happens in the tissues that renders them able to cope with an invasion of pathogens. The problem has been to account for already existing resistance to infection; of that resistance which develops during infection; and of that which persists after infection, so that no new infection of the same sort is possible. It has been necessary to account for relative and absolute degrees of resistance; resistance that is present at some times and not at others; resistance when bacteria are received on one tissue of the body, and lack of resistance when they are received on another tissue. Finally, it has been necessary to account for that resistance which is more or less general against all bacteria, and that which is present against only specific bacteria.

At the same time it has been necessary to study the converse of resistance, or susceptibility. Theoretically it is the absence of resistance, but practically it is spoken of as though it were a positive state in itself, in which tissues are not merely not resistant, but seem to be more prone than usual to infection.

Knowledge of resistance and susceptibility was gained first through the clinical observations of what actually happened in life when individuals were exposed to infection. Later, after clues were obtained as to the possible explanation of the

phenomena of immunity, the science of immunology developed as one of the branches of experimental biology.

The earlier observations seemed to show that immunity might be either natural or acquired, and this fact has been borne out by more recent investigations. Natural immunity is that with which an individual is born. Acquired immunity is that which develops during an individual's own lifetime.

It has been a matter of common observation for centuries that individuals who have had an attack of a disease of certain varieties are unlikely to have that disease again. This is not true of all infections by any means, the reverse often being the case, the attack leading to greater susceptibility to the same disease thereafter. One is likely to acquire fairly complete immunity to such diseases as smallpox, scarlet fever and mumps. On the other hand, if no immunity to a disease is produced by one attack of it the individual seems to be more likely than before to be infected by the same bacteria. Among the diseases to which susceptibility is increased are colds, tonsilitis, bronchitis, pneumonia, influenza, rheumatic fever and infectious disease of the lining of the heart.

The study of the cells and fluids of the body before, during and after an infection has led to much knowledge about the cause of this important phenomenon called resistance or immunity. It has been learned that resistance to bacteria is of two sorts, that which is general, and acts to a greater or less degree against all bacteria; and that which is specific, acting only against given bacteria. In Theobald Smith's formula R means resistance of either or both sorts. Sometimes there will be a high degree of general resistance to most infection and none at all against some one specific infection.

Important as general resistance is, it has no appreciable value against many bacteria unless there is also specific resistance against the particular invader. For example, it is impossible to keep the general resistance good enough to prevent smallpox unless one has specific resistance against smallpox either because of having had an attack of the disease or because of having been vaccinated. Often the strongest individuals, whose general resistance was high, fell victims to the new and virulent organisms prevalent in the

influenza epidemic of 1918, to which very few seemed to have specific resistance. On the other hand, general resistance is an important factor against one particular disease, tuberculosis. In the present state of our knowledge, no way of increasing resistance against tuberculosis has been devised equal to that of keeping the quality of the tissues of the body such that all functions are satisfactorily performed. The same is more or less true of colds, and of several other common infections. No individual's resistance is such as to make him immune to all infection, although he may have a large number of specific resistances.

When the terms immunity and susceptibility are used they should be understood to mean chiefly specific immunity or susceptibility in respect to given bacteria. In efforts to render one's self free from infection one must consider both the upbuilding of general resistance and the means for acquiring specific resistance. In the formula, M should be considered as representing special bacterial invaders, and R as specific resistance against that sort of bacteria, as well as general resistance that will be of more or less value according to circumstances.

General resistance, since the announcements of Metchnikoff in 1864, has been largely attributed to the phagocytic action of the white blood cells and of some of the fixed cells of the body. The cessation of a number of kinds of infection is undoubtedly thus to be explained. This is not, however, the whole story, even in regard to general resistance.

To account for specific resistance it was necessary to consider other factors in the body than the white blood cells. It is now known that there are, in the body, and circulating in the blood, many separate kinds of chemical substances, each one of which is capable of neutralising the poison of some special bacteria, while having no effect on all other bacteria. It is this that constitutes specific immunity. As has been said, such immunity is either inborn or acquired. It is the product of the interaction of the body cells and bacteria. The presence of a given sort of bacteria produces what are called anti-bodies against that particular bacteria. If there are sufficient anti-bodies of a special sort the body is immune to the type of

bacteria responsible for the creation of the anti-bodies. Anti-bodies are not bodies in the literal sense, so far as is known, but are chemical substances.

In infections from which the individual recovers but has no subsequent immunity, it must be concluded that a number of anti-bodies were produced sufficient to neutralise the given infection, since the individual recovered from it, but that no excess was formed for future use. Not only was there no excess of anti-bodies, but the body cells were to a certain degree less well off than before in respect to invasion by the given bacteria. Although one victory was won, it was barely a victory and left the forces somewhat depleted.

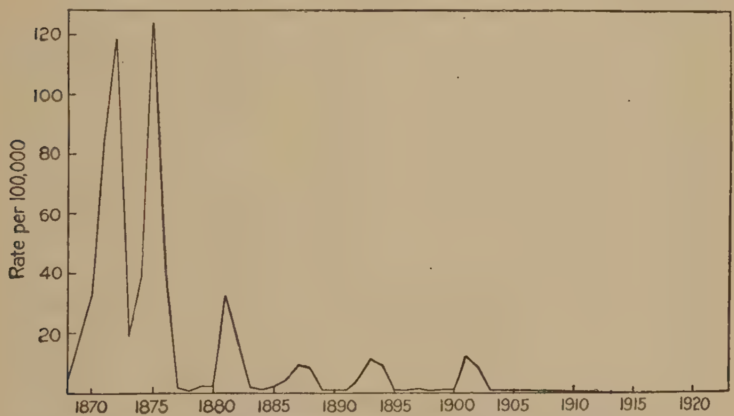

Fig. 154.—Mortality rate by years for smallpox, New York City. (From Moore, "Public Health in the United States," Published by Harper & Bros.)

The simile of battle has often been used in respect to infection. The term "fighting a cold" is really justified, as the combat between bacteria and tissues is not unlike warfare. Unless there is a decisive victory over any infection, the only partly victorious army may be an easier prey for the next invaders.

The study of the blood serum, and the resulting knowledge regarding the production of anti-bodies, has not done away with our belief in the necessity for a satisfactory maintenance of general resistance. It has, however, made it possible to

understand equally important body needs in dealing with infection; and, most important of all, it has led to the discovery of the method of producing anti-bodies in laboratories, so that individuals may be rendered immune before exposure to bacteria of certain sorts (e.g. typhoid), or aided in combating them after they have produced illness (e.g. diphtheria).

We have already classified resistance as natural and acquired. It is now necessary to subdivide acquired immunity into that which follows disease and that which is artificial—the latter used either before disease to prevent it, or during disease to help the body overcome it.

The first important observations of a scientific nature regarding a state of resistance that amounted to absolute immunity to a given infection were made by Edward Jenner in 1798. He noted that whereas practically all persons were susceptible to smallpox and actually had the disease, there was one class of individuals—the milkmaids—who did not have it. He sought to find out what differentiated the milkmaids from all others in this respect. It took him only a short time to discover that dairymaids usually had had on their hands a mild skin disease which they had acquired while milking cows that had a similar disease, called cowpox. His conclusion, although unsupported by any knowledge science had at that time, was that some change took place in the individuals who had the disease cowpox, that rendered them unable to acquire the far more serious disease called smallpox.

Jenner was able to convince the world that a state of immunity to smallpox could be produced in a simpler way than by having an attack of that disease, with all its possible hazards. The suggestion he made to the world was that individuals should voluntarily acquire the milder disease in order to prevent the more serious one. Smallpox was, and still is, a disease that is often fatal, and that, in those that survive, leaves scarring and often blindness. In order to avoid smallpox, the public welcomed the opportunity to be inoculated with cowpox. Jenner's method spread all over the world, and Jenner himself became one of the greatest heroes of public health, and one of few who have achieved due recognition

during their own lifetime. His fame was due to the fact that vaccination proved to be as successful in rendering persons immune to smallpox as though they had had that disease instead of vaccination. Improvements continue to be made in the method of vaccination, and it is now the most entirely successful of our methods of producing immunity.

Since Jenner's brilliant discoveries regarding artificial immunity, others of equal brilliance have been made. It is now possible to make substances that will, when inoculated into the body, prevent diphtheria, typhoid and a number of

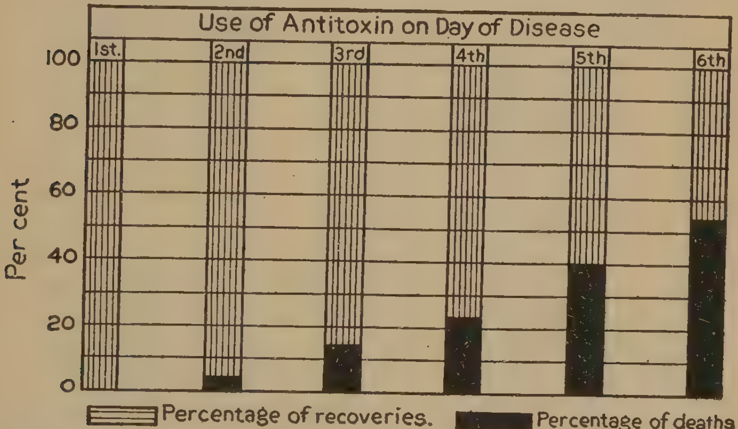

Fig. 155.—Percentages of recoveries from diphtheria when antitoxin is administered on various days in the course of the disease. Prepared by Schereschewsky on data of Kolle and Hetsch. (From Moore, "Public Health in the United States," Published by Harper & Bros.)

other diseases. It is also possible to produce substances that will cure some of the bacterial diseases. These biological products act in one of two ways. Either they confer a ready-made immunity which the body merely passively receives and utilises; or they stimulate the body to produce its own anti-bodies. The former is called passive immunization. An illustration of it is diphtheria antitoxin, which is produced in an animal by rendering the animal immune. Serum from the immune animal then has the power, when introduced into another animal, to make it more able to overcome infection with the bacilli of diphtheria. Diphtheria antitoxin is one of

the most important of all curative measures. When substances are introduced into the body for the purpose not of conferring passive immunity, but of stimulating the body to produce its own immunity, the process is called active immunization. It is in all respects analogous to what happens in infection—that is, if immunity actually is produced when

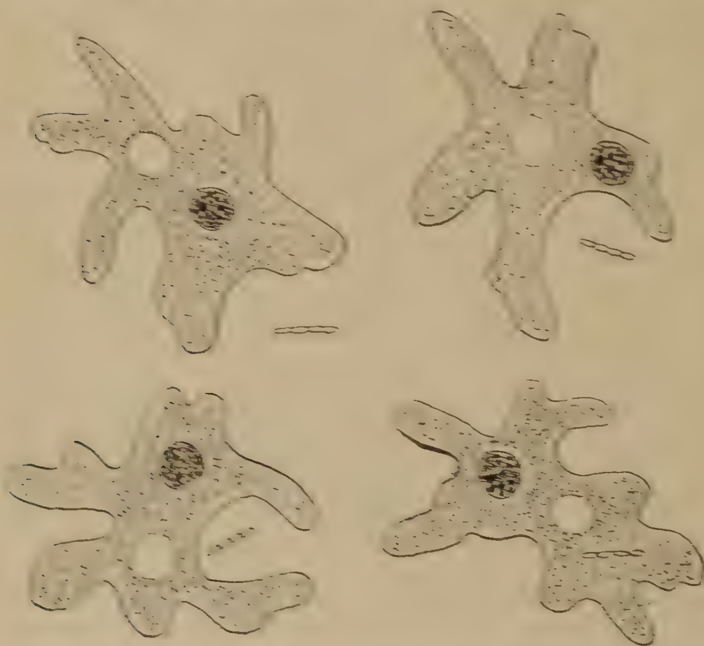

Fig. [illegible].—White blood cell engulfing foreign material, e.g. bacteria. The process of phagocytosis.

disease is present. Artificial immunization gives no disease at all, but only immunity, which is as complete as though disease had been present. The reason that immunity is produced is that the vaccine arouses in the body the same attempts at resistance as would the corresponding infection; the reason that no disease is produced is that the vaccine contains only a minute dose of killed bacteria—not bacteria such as could cause disease. One of the best illustrations of active immunization is that afforded by typhoid vaccine.

Theoretically it should be possible to immunize against all bacteria. As yet, however, there have been developed only a few such immunizing substances. A few other substances have been developed that are used when disease is present, for the purpose of cure. Whenever such prophylactic biological products are available they should be used without question, since they represent the most direct and natural attack against bacteria.

Although general resistance by means of phagocytes cannot be relied on to take the place of these specific substances there is every reason for keeping the general resistance high. Even the specific protective substances may be produced more

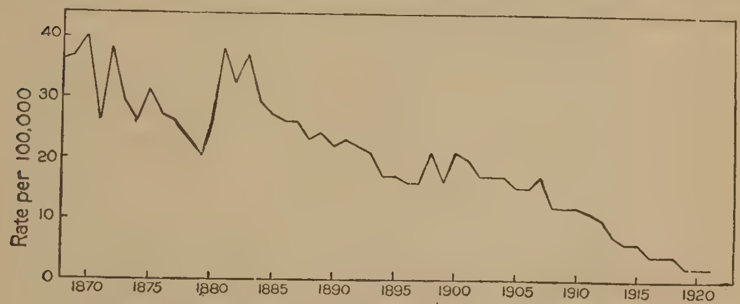

FIG. 157.—Mortality rates from typhoid fever by years, New York City. (From Moore "Public Health in the United States," Published by Harper & Bros.)

effectively by the body in case of need if the measures such as keep up general resistance have been used.

It is quite commonly observed that general resistance is lessened by certain changes in environment, ways of living and physical condition. Exposure to wet and cold lessens resistance, for example. It is also frequently observed that fatigue lessens resistance. This can be demonstrated experimentally in animals. After an amount of work that produces marked fatigue, an animal can be inoculated with an infectious disease more readily than when not so fatigued. It is thought that part of the explanation may be due to the fact that fatigue products are acid, and that the protective substances in the blood serum do not act as well in an acid as in an alkaline medium. It is also thought that white cells may be injured by katabolic products.

Starvation, or indeed malnutrition, tends to lower resistance. This is due to lack of good quality of tissue cells, white cells and blood serum. It is thought that it may be partly due to the lack of vitamines in an improper or insufficient diet, which

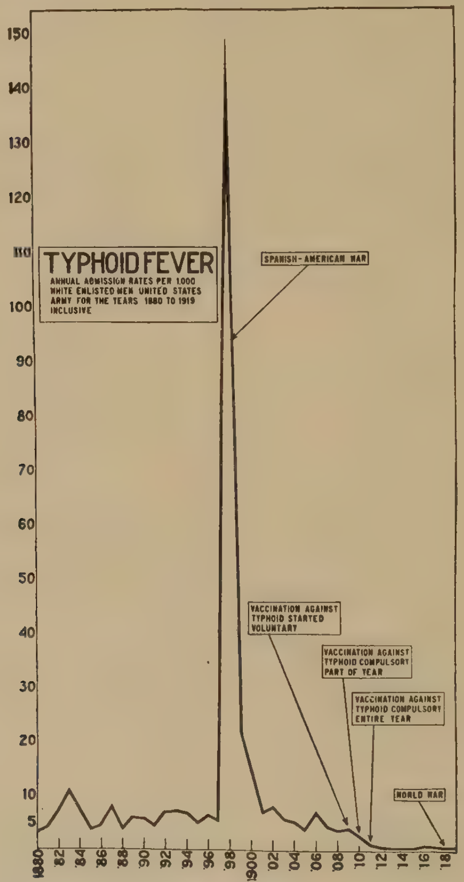

Fig. 158.—Typhoid fever rates in the United States Army, 1880–1918. (Used by permission of the Surgeon General.)

causes tissue impairment such as favors infection. Lack of sufficient quantity of food is in itself of great importance.

Certain drugs, especially alcohol, seem to have a prejudicial effect on general resistance. Alcohol seems to interfere with phagocytosis on the one hand, and to produce cell impairment

on the other hand. Pneumonia, which depends somewhat at least on general resistance, is particularly frequent in the alcoholic, and particularly fatal. Physical defects of various sorts lead to lowered resistance. Chronic infection is a constant tax on the defense mechanisms, and they often cannot be aroused to very great activity if new infection enters. Any chronic or constitutional disease is likely to give enough change in body cells to render them non-resistant, especially if the disease entails poor diet, lack of exercise and of fresh air. Lowered vitality during convalescence from acute illness gives sufficient general impairment of body processes to render those recovering from illness easy victims of new infection, or of re-infection of the same sort. Mental strain has been questioned as a cause of lowered resistance. Probably if infection follows such strain it is due to changed habits of living, such as loss of sleep, that accompany the strain. A disturbed digestion or faulty elimination may produce poisons which circulate and act as do fatigue toxins in interfering with cell activity, especially of the leucocytes. The taking of a cathartic at the beginning of an acute infection, such as a cold, and the careful regulation of the diet and the drinking of much water during the illness, are measures based on this theory.

Many other ways might be mentioned by which resistance is lowered, for anything that interferes with the normal functioning of all parts of the body probably has this effect to a greater or less degree. On the other hand, it is equally true that whatever aids body functions will to some degree increase the power of the body to cope with infection. It should always be recalled, however, that general resistance may not be relied upon exclusively. It should not be relied on at all, if such reliance leads to unwise exposure to infection; nor if it leads to neglect in securing whatever special forms of resistance are available (as immunity to smallpox and typhoid); nor if it leads to the expectation of cure of infection without suitable care. Although it is desirable to keep in the best of health, infection is often no respecter of even a sound constitution. It is necessary not only to be well but to use intelligence, if one would have a well-founded expectation of preventing infection or of recovering from it promptly.

CHAPTER XXII

POISONS

The substances that are poisonous to man come either from within his own body or from without it. Those from within the body have been mentioned elsewhere. They include substances produced as the result of metabolism, such as would not be poisonous if removed as they are intended to be. The retention of waste after the time when it should be eliminated gives varying degrees of poisoning. This is true of intestinal waste to some extent. It is thought that the absorption of products of decomposition in the intestinal tract—partly due to delay in elimination—adversely affects the tissues of the arterial system, and thus, through affecting the circulation, adversely affects many organs. Particularly is it true that the body is harmed by the retention of urea, which ordinarily should be excreted by the kidney as fast as it is formed in the liver and elsewhere. The retention of bile, and its subsequent absorption by the body, is also harmful, producing as it does a general poisoning, showing icterus or jaundice.

The internal secretions as well as the external secretions may occasionally act as poisons. But this, in the case of the internal secretions, is not due to failure of elimination, but to their production in excess of the body needs, or to change in their quality. The thyroid gland in particular may produce so much of its secretion, or so different a secretion, as to give a condition that is known as "toxic" goitre—toxic in that the system is poisoned thereby.

Another sort of poison produced within the body, although not by it, is the poison of bacteria. Bacteria, in interacting with the cells of the body, give some of the most severe sorts of poisoning. The poisons are produced locally, where the bacteria are, but may be carried all over the body, giving a state called toxemia (poisons in the blood). This happens in

varying degree in most acute infections and also in most chronic ones. It is responsible for much of the feeling of illness that accompanies infection. Infected tonsils or teeth are among the most common conditions in which bacterial toxins are constantly being produced.

Poisons from without the body include some kinds of food, or substances taken as food. In the latter group are, for example, certain kinds of inedible mushrooms. Poisoning may occur, however, from food that would ordinarily be edible but has become spoiled or infected. In such cases a condition known as ptomaine poisoning often results, which, however, is thought to be due to bacteria in the food, rather than to chemical changes in it. A particularly severe sort of food poisoning is due to the bacillus botulinus. Several outbreaks of it have occurred in connection with the eating of infected ripe olives. It should not occur in properly prepared food, put up by reliable companies. There is a curative antitoxin for this infection.

Sometimes food that is well suited to most individuals acts as a poison to some few individuals who, in such circumstances, are said to have a personal idiosyncrasy against the particular food. Among the symptoms produced may be a rash, called urticaria or "hives."

Aside from the sorts of poison already mentioned there are many chemicals that may poison. The industrial worker is the most likely to be exposed to chance poisoning by chemicals, although all classes of individuals encounter such danger.

The public health measures that are being taken to limit the possibility of poisoning from the chemicals necessarily used in industry are among the most important of modern preventive medicine. Much legislation has been passed with a view to protecting the health both of workers and of those who use the manufactured articles.

The poisonous chemicals may be in the form of gases, fumes, dusts, solids or liquids. The effects they produce are various. Some chemicals produce no effect where they enter the body, but proceed to combine with various tissues or organs and interfere with their functioning. Others produce a greater or less degree of local damage.

The most serious local damage is caused by the corrosive poisons, chiefly the strong acids and alkalis. They have a coagulating effect on tissues similar to that produced by heat. The degree of local destruction of tissue depends on the chemical, its concentration, the part of the body to which it is applied (skin is more resistant than mucous membranes), and the rapidity with which it is neutralized. Ordinarily acids are to be neutralized with alkali, and vice versa.

The poisons that do not cause local damage, or damage only of an insignificant sort, are injurious in one of two ways—either they affect body functions at once, or else they are accumulated in the body and gradually damage it.

Of the first sort are those that greatly stimulate the system (such as strychnine), and those that greatly depress it (such as acetanilid). A fatal degree of stimulation or depression is possible from many poisons. Many medicines are capable of one effect or the other if taken in over-dosage.

Of the second sort—the cumulative poisons—may be mentioned lead, that gives a slowly developing poisoning especially likely to appear in those who work with lead, and do not take precautions against it. Some hair dyes and cosmetics contain lead. The narcotic drugs belong in the group of cumulative poisons, for the degree of poisoning increases as the drug continues to be used. The same is true of alcohol. Wood alcohol, however, belongs in the list of those that do more immediate harm. It has a selective action on the nervous system, causing blindness, cardiac paralysis and death, even in quite small doses. Poisoning from synthetic alcoholic beverages is likely to be of this sort.

There are many gases that poison, but carbon monoxide is the only one that is a particular menace outside of industrial and chemical plants. This is the gas that is produced as the result of imperfect combustion in stoves and furnaces. If a furnace is improperly constructed or operated, it may give off enough coal gas to endanger occupants of the house. Harm may usually be prevented by a proper use of the draughts—by leaving them open long enough after coal has been put on the fire to produce red flames instead of blue. The exhaust gas of automobiles contains a high percentage of carbon monoxide.

Illuminating and fuel gas consists of carbon monoxide. Many cases of poisoning are due to leaks in pipes and fixtures, or to lack of care in closing the cocks. Acute poisoning and death may result, or a chronic minor degree of poisoning that gives symptoms of ill health that are not well-defined. Carbon monoxide poisons because it combines with the hemoglobin and prevents oxygen from doing so. The individual suffers from either acute or chronic oxygen starvation.

A great deal of poisoning is due to carelessness or ignorance about simple matters. It ought not to be necessary to mention that poisons should not be kept about the house, or, if they must be, that they should be in properly labelled containers. They should never be where they can be confused with harmless substances, or within reach of children. No medicine should ever be taken internally or applied to the skin or mucous membranes without carefully reading the label on the bottle. No medicine should ever be taken or applied in greater strength than that directed. No medicines should ever be taken upon one's own initiative, especially if they are of unknown composition, or were prescribed for somebody else, or have possibly undergone poisonous decomposition through ageing.

Substances used for photographic purposes, most disinfectants and insecticides, many cleaning fluids and silver polishes contain poisons. Some of them even contain some of the most deadly poisons.

The treatment of acute poisoning by first aid measures in the hands of laymen is not very satisfactory. In the case of gas poisoning artificial respiration should be done, however. In the case of acid or alkali burns, neutralizing alkali or acid may be applied, or, if the poison has been taken internally, a weak neutralizing solution may be given. Bicarbonate of soda is a weak alkali; and vinegar or lemon juice, weak acids. In most cases of poisoning the first thing to do is to get a physician, or someone who has a knowledge of poisons and of the body—a nurse, a druggist or dentist. It is only when no such assistance is available that the layman should rely upon his own efforts. If one is to be remote from all assistance, he should be equipped with a first aid kit and directions for its use.

CHAPTER XXIII

ACCIDENTS

The most common result of accidents is trauma of the body. The term means wound or injury, and is usually applied in medicine to those due to mechanical causes, although it is also applied to some other forms of injury.

Mechanical causes of trauma may produce effects suddenly or gradually; and the effects may be mild or severe. The most serious trauma is usually, although not always, that which appears suddenly. Prolonged, slight injury may be equally serious.

The injuries that are produced by mechanical agencies are classed as contusions, wounds, strains, sprains, dislocations and fractures.

Contusions are commonly known as bruises. The skin is not broken, but is damaged, together with the underlying tissues. There is no bleeding from the skin, but there is rupture of capillaries underneath. Often there is a good deal of swelling. Later it becomes the familiar "black and blue" spot. Often the pain does not begin at once, and if cold is applied to keep the part from swelling it may not be at all painful. After the first stage of contusion, hot applications may be used to hasten its recovery. Contusions are usually present when there is fracture or sprain, but do not necessarily indicate an injury to a bone or joint. If the contusion does involve a bone or joint the swelling and discoloration are likely to continue longer than is the case in a simple contusion.

Contusions of the head are usually more serious than others. The individual may be stunned, or in other words suffer from concussion of the brain. There are various degrees of concussion, some of which are not at all serious. Slight degrees of concussion are quite common. The symptoms are like fainting, although unconsciousness may not take place. The

treatment differs from that used for fainting, in that no stimulants (e.g. aromatic spirits of ammonia) are used, and the head is slightly raised instead of lowered, in order not to increase the flow of blood to the brain. It is desirable to have medical attention for severe contusions of any part of the body, in order to make certain that there are no fractures or other serious injuries.

Wounds are classified as abrasions, in which the skin is slightly broken; lacerations, in which it is torn; incised wounds or cuts, made with sharp instruments; penetrating wounds, in which a small surface is involved but the depth of the wound is relatively great in comparison with the amount of surface injury—e.g. pin pricks, nail punctures, and bullet wounds. If associated with contusion they are called contused wounds. They all cause the escape of blood, except possibly the punctured or penetrating wounds that often close over at the top at once. The chief dangers from wounds are the bleeding, which may be severe, and the possibility of infection.

Infection may result from the entrance of bacteria that are already in or on the skin, or from bacteria introduced at the time of the accident, or afterwards, by the hands or objects that touch the wound. To prevent infection, wounds should be cleansed. If grossly contaminated by visible dirt they should be washed with soap and water and gauze, wiping always away from the wound; rinsed with clear water; and painted with iodine or a similar disinfectant. Gauze or some other sterile white material should then be placed over it. If no sterile gauze is at hand, a handkerchief may be ironed until it is slightly scorched, and a part of it that has not been touched by the hands applied to the wound.

If the injury is small and supposedly not contaminated, iodine and a dry sterile dressing is all that is needed. Even a pin prick should be thus treated with iodine, for any minute wound is large enough to hold millions of bacteria. Adhesive plaster or flexible collodion (liquid court plaster) should not be applied directly to an abrasion. If the injury is on the hands, care should be taken not to get the dressing wet. If the abrasion is on the foot, healing will be slow if the foot is used for walking, unless the dressing is such as to remove pressure from the

injury. Wounds that involve the retaining of any foreign material, such as splinters, should not be dressed until the foreign material has been removed. Splinters should be removed by means of a needle sterilized in a flame, or by other instruments in the hands of physicians, and then treated as other wounds.

If no bacteria remain in the wound it should heal at once. Cuts should heal by first intention if sterilized and dressed so that the edges remain together. If some of the surface of the skin is destroyed it takes longer for repair, in proportion to the amount of repair necessary. In the case of cuts it may be necessary to use stitches to hold the edges together. Extensive loss of skin surface is sometimes treated by skin grafting.

Even extremely minute wounds need attention. Scratching the skin with the finger nails may make small breaks that allow bacteria to enter. Undoubtedly acne is perpetuated in some individuals by the habit of picking at the pimples and introducing more bacteria into the skin. The minute cuts or abrasions made in shaving usually heal promptly, except those that are made in shaving under the arm, where conditions are more favorable for infection. Infection is very common in the minor breaks of the skin about the nails, due either to careless manicuring or lack of manicuring. Such injuries should be treated as mentioned, for they are wounds. In fact the most insidious danger of infection is from small, untreated, unperceived wounds, and from inadequately self-treated ones.

The signs of infection are those of inflammation—redness, warmth, pain and swelling in the part involved. The injury itself, without infection, may cause these symptoms to some degree, especially if it is in a part of the body that is hard to protect. As much protection as possible should be given any injury, in order to give it a chance to repair. Motion in the part, or continued knocking or striking of it, may delay the process.

If the pain is quite noticeable and the signs of inflammation are marked it should be seen then, if it has not been before, by a physician. This is particularly true if there is any fever, any pain or swelling in the communicating lymph glands (as under the arm when the hand has been injured), or if faint red

lines are to be seen on the skin radiating from the injury. The injured area may have hot wet compresses applied to it and the part kept at rest, pending the receiving of medical attention.

There will be no red lines (inflamed lymphatic vessels) if an infection is spreading by the blood vessels. The latter type of infection is called septicemia or blood poisoning, and is often very serious, even when arising from slight injuries. The symptoms may be insignificant locally, but the constitutional symptoms (fever and prostration) may be marked. Most infected wounds, however, do not cause either of these unfortunate results if they are properly treated.

FIG. 159.—Nail, carrying tetanus organisms, entering foot.

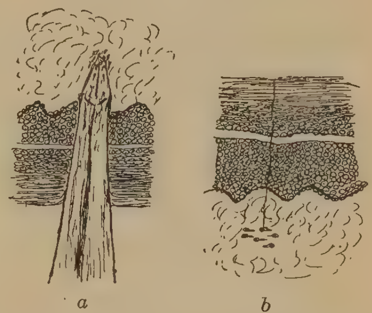

FIG. 160.—*a.*, Tetanus organisms being carried into the tissues; *b.*, nail has been withdrawn, edges of the skin have come together, leaving bacteria in the skin and shut away from the air.

Penetrating wounds, such as those made by tacks and nails, are particularly likely to provide deep pockets in which bacteria may hide and multiply. The wound that closes over at the top favors the bacteria that grow in an airless (anaerobic) medium. Chief among these is the organism of lockjaw (tetanus). Rusty nails are associated with lockjaw not because of the rust, but because the same conditions that caused them to rust also caused them to be infected with these organisms—that is, lying out on the ground. These bacteria are most frequently found in the soil and in street dirt. Injuries contaminated with soil, whether they are produced by a nail or not, should always be carefully treated, although

there is little danger unless the bacteria become shut away from the air in the wound. Sometimes the punctured skin wound must be opened more widely to allow air to enter. If conditions are such that infection is suspected, the antitoxin against tetanus is used. It is without danger, and gives much reassurance. Most penetrating wounds of all sorts are better not self-treated. Penetrating wounds, or in fact any wounds, from the teeth of a dog that is rabid or "mad," or is suspected of being so, need immediate medical attention in order that prophylactic measures may be used.

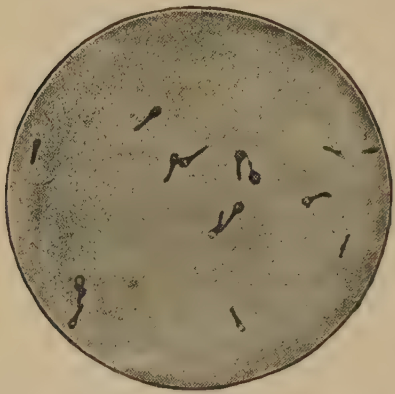

Fig. 161.—The organisms of tetanus (lockjaw). (MacNeal.)

A common complication of many kinds of wounds is hemorrhage or bleeding. It is best controlled by continued pressure on the bleeding area, maintained either until the bleeding stops or until help arrives. Tourniquets tied about a limb are seldom so effective or safe in the hands of laymen. Nosebleed is best treated in the same way. The bleeding vessel is usually well within reach of the finger, on the middle partition of the nose. The finger should be wound about with gauze or a handkerchief, and a steady pressure applied for several minutes. Whenever there is bleeding, it is better for the individual to be lying down. In removing the pressure from a bleeding point care should be taken to do it gently, in order not to break away the clot which has formed and which seals the blood vessel.

There are two varieties of wounds that are produced slowly. One sort is due to irritation, which may be so marked as to cause ulcer or possibly even cancer. In view of the possibility of serious consequences, one should attempt to avoid all chronic irritations. The other sort of slowly produced injury is that due to pressure or rubbing. Bunions and corns illus-

trate the effect of pressure, and blisters, the effect of rubbing. Rubbing, however, may not produce blisters but other forms of skin irritation.

The forms of trauma that affect muscles most often are strain and rupture of either the muscle itself or of its tendon. The strain may be acute, as in the back muscles as a result of lifting; or it may be chronic, as in the same muscles as a result of poor posture. Strain usually follows an excessive amount of work of the muscles, but there is also often an element of faulty use. Writer's cramp, for example, seldom follows correct use of the arm muscles in writing. The ailment called "Charley horse" is an acute strain of muscles. A condition called "glass arm," that occurs in baseball players, is due to strain of the tendon of a much-used muscle. Generally speaking, strain is less likely to occur if training has been gradual, the technique correct, and the use not excessive or continuous.

The forms of trauma that affect joints are chiefly sprains and dislocations. Joints are also affected by the trauma they receive as a result of not being held firmly in their proper position—as, for example, irritation of the knee by lack of proper use of the leg muscles, such as occurs when the foot is pronated.

In sprain the joint is usually more suddenly and markedly involved. At the time of the injury the bones may have been temporarily placed out of their usual relation to each other, and ligaments may have been torn. There is often considerable injury of the soft parts about the joint. Not infrequently there is fracture of some of the bones in the ankle or wrist in severe sprains of these joints.

If a sprained joint is not used for a few days, but kept in a horizontal position, possibly with an icebag on it, it is likely to return to normal in a short time. Bandaging, strapping or plaster are usually used, at least when use of the part is begun. Treatment in acute sprain, and also in chronic sprain of joints, necessitates getting the joint structures into proper relation with each other and retaining them there until muscles and ligaments are able to retain them unaided. Too early and too much use may result in the ligaments delaying in

their return to normal holding power. Sprain of the back or of the knee usually requires a longer convalescence than is necessary in the case of some of the other joints.

Dislocation differs from sprain in that the bones remain out of their proper relationship to each other until put back. Dislocation has often occurred in sprain, but has been immediately and spontaneously corrected. Because of possible further harm to the joint by unskilled manipulation of it, dislocations should usually be reduced by physicians. It may require several weeks before the joint is as firm as before.

When a joint repeatedly "slips out"—i.e. is subject to recurrent dislocation—the condition may be due to too early use or other lack of care at the time of a first dislocation. Habitual dislocation is common in some individuals who are loosely built and not muscular. There are no really "double-jointed" individuals.

Fracture is the technical term to describe a break of a bone. Fractures may be across a bone, or lengthwise, or at an angle. They may be complete, or extend only part way across the bone. Sometimes only a small piece of the bone is chipped off. The parts of the bone may or may not be displaced. Nerves and blood vessels may or may not be injured. A compound fracture is one in which an end of the bone penetrates through the skin or the mucous membrane to the surface. An impacted fracture is one in which one piece of the bone is driven into the other piece. There is variation in susceptibility to fracture according to the brittleness of the bones. The young are usually less likely to have complete fractures than those who are older.

Fractures cause pain and tenderness, and the individual is not able to move the part as usual. The changed contour of the part may be obvious, although if the fracture is near a joint it may resemble sprain or dislocation. If fracture is suspected the part should not be manipulated at all, but medical attention be secured. An X-ray may be necessary to diagnose a fracture.

The aim of treatment is to get the two ends of the bone together and to hold them there until they unite and the bone is strong. Sometimes an anesthetic is necessary to secure

satisfactory reduction; occasionally an operation is required. Splints or plaster must usually be kept in position for a number of weeks. After healing, the bone should be as strong as ever, although fractures into or near joints may give limitation of motion at the joint thereafter.

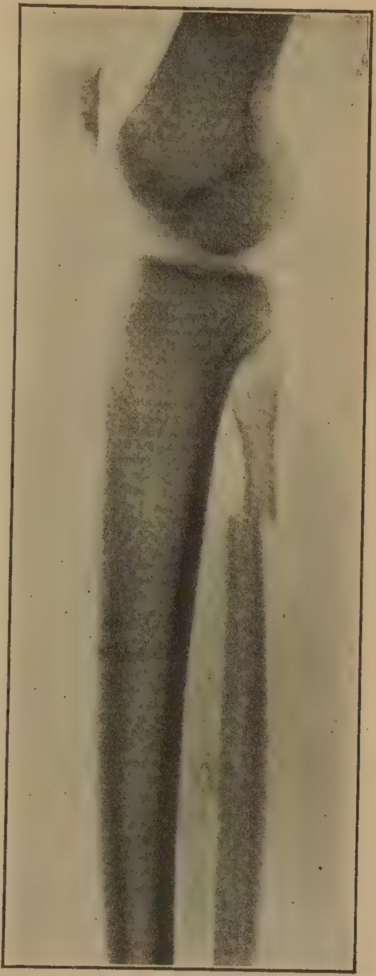

Fig. 162.—Fracture of the fibula. (Courtesy of Dr. M. E. Cooney.)

It should be noted that many kinds of injury may be produced by a single accident. Laceration of the skin, contusion of the soft parts, sprain of a joint and fracture of a bone may result from a fall on the knee, for example. Each kind of injury needs special treatment.

Thermal accidents are less common than mechanical ones. The injury done by heat and cold depends on the intensity of each, and the duration of its application.

Burns are of several different degrees. In the slightest burns there is merely redness of the skin, with, perhaps, blister formation. In the more severe burns there is charring and coagulation of the tissues. If small superficial burns are properly treated very little pain is experienced and, in most locations, no after results. No bacteria survive the burn, and infection only results through careless subsequent handling. Oily substances are the best first aid measures, together with covering of the burn with clean material. Severe burns should

preferably be left uncovered and untouched until they can receive medical attention. A very extensive burn may so interfere with skin function and temperature regulation that death may result.

The treatment of blisters consists of leaving them alone unless they are in an inconvenient location and thus likely to get ruptured. If so, one may sterilize scissors and nick the

Fig. 163.—Impacted fracture of the radius. (Courtesy of Dr. M. E. Cooney.)

blister at the edge to let the fluid run out, leaving the layer of epidermis in place. It should then be covered with a sterile dressing. Burns from acids or alkalis should have the appropriate neutralizing chemical applied, and then treated as other burns.

The local effect of extreme cold is much the same as that of extreme heat, although usually less severe. The nose and ears and extremities are the parts most often frozen. The blood is driven away from the surface and the skin looks pale. At first the parts feel cold, but later sensation is lost. The

aim should be to thaw the part slowly, not by rubbing it in snow or ice water, but in moderately cold water, very gradually warmed.

Chilblains are the result of less severe exposure. The tissues become red and swollen and painful, and may blister. After the toes have once been frost-bitten they may thereafter be subject to this annoying condition, especially if they were warmed too rapidly on the first or subsequent occasions.

The constitutional effects of exposure to extreme heat are of two varieties—heat-stroke or sunstroke, and heat exhaustion. In the former there is great increase in body temperature, even up to 108° F. The surface of the body is hot and dry and red. Collapse and perhaps death may follow. It is particularly likely to occur in chronic alcoholics, but may occur in those who are temporarily under the influence of alcohol, or in any individual who is exposed too long to the sun while too heavily clad and carrying on too heavy physical exertion. The aged and feeble are also especially prone to feel the effects of exposure to the sun. An individual suffering from heat- or sunstroke should be quickly removed to as cool a place as possible and every effort made to cool the surface of the body by applications of ice or cold water. If the individual is not unconscious, cool drinks may be given. After having such an experience once the individual is more prone to experience it again unless precautions are taken.

Heat exhaustion is not quite the same as heat-stroke. It leads to a great depression of physical functions, with a reduction in body temperature. This is also more common in alcoholics, but is not rare in the feeble and the undernourished. It is to be treated in much the same way as fainting. The body is to be warmed rather than cooled. Stimulants may be required.

Both of these effects of exposure to heat may be prevented by maintaining good general condition and using some discrimination about hygiene in hot weather. It is not wise to eat too lightly in summer, nor is it wise to eat too heavily, especially of protein and sweets. There should be some limitation of very active exercise in the very hot sun. Men in

particular need cautioning against dressing too heavily. In general it is better not to take too many hot baths. Temperature regulation is favored by the drinking of a good deal of cool fluid. Those who are underweight and feeble, and those who are over weight need to use special care in hot weather.

The effects of exposure to extreme cold are as severe as exposure to extreme heat, although less frequently seen. Those who are exhausted, ill or undernourished stand exposure to cold badly. The aim, as in all chilling of the body, is to get it warm again, by the application of heat externally and the taking of hot liquids. Sometimes stimulants are necessary. It should be mentioned that alcohol before possible exposure to cold renders the individual more liable to harm than otherwise.

The effect of a strong electrical current on the body is that of local burns, that are to be treated as other burns; and that of suppression of the action of the heart and of respiration. The most important part of treatment for the electrocuted is artificial respiration, after contact with the current has been broken by the use of a non-conducting material in the hands of the rescuer.

Asphyxiation involves shutting off the air supply to the cells of the body. It may take place as a result of paralysis of respiration, or of blocking of the air supply to the lungs. The cause of the former is often asphyxiation by a gas; of the latter, drowning. The former is to be treated by artificial respiration. Asphyxiation due to water in the lungs should be treated first by efforts to remove the water. The individual should be placed face downward on the ground, and someone standing astride over him should then lift his body at the waist line until it is several inches above the ground. If breathing does not begin automatically, artificial respiration should be done. The method illustrated is one of the most effective.

Other substances than water occasionally shut off the air supply by getting lodged in the trachea or bronchi. If breathing is not too seriously interfered with it is not a matter of the greatest urgency, and one may wait for medical attention. Sometimes the offending object may be dislodged by placing the individual face to the wall and slapping him gently on the

FIG. 164.—Artificial respiration to be preceded in the case of drowning by the evacuation of the water.

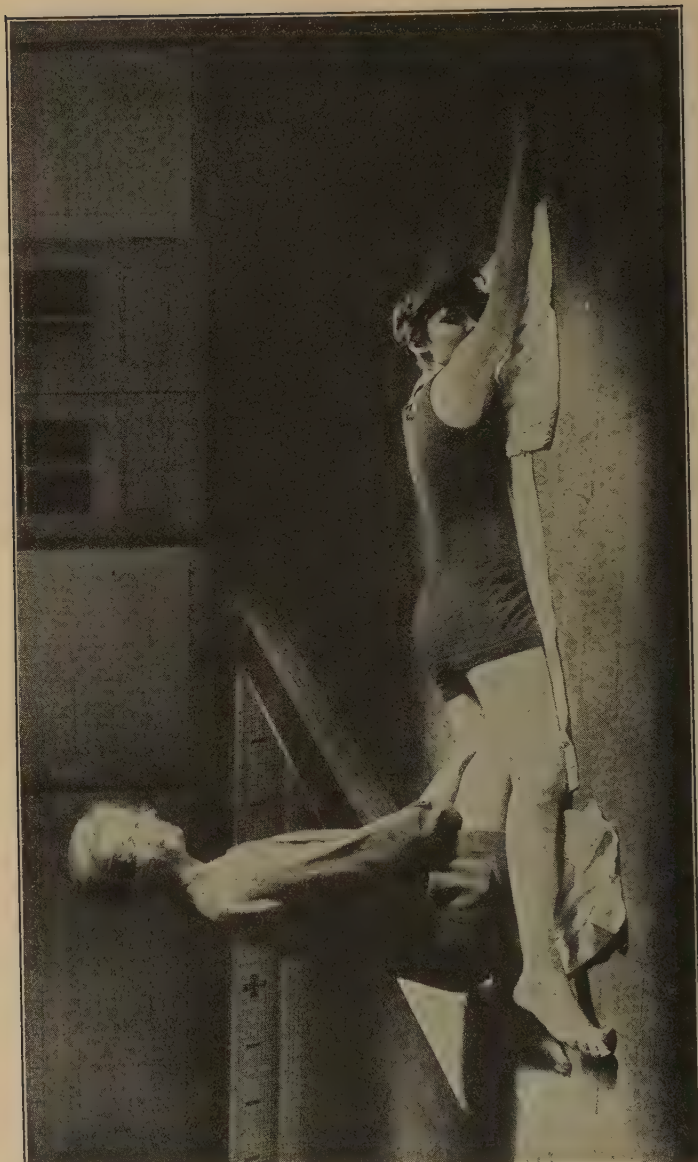

Fig. 165.—Artificial respiration. First position.

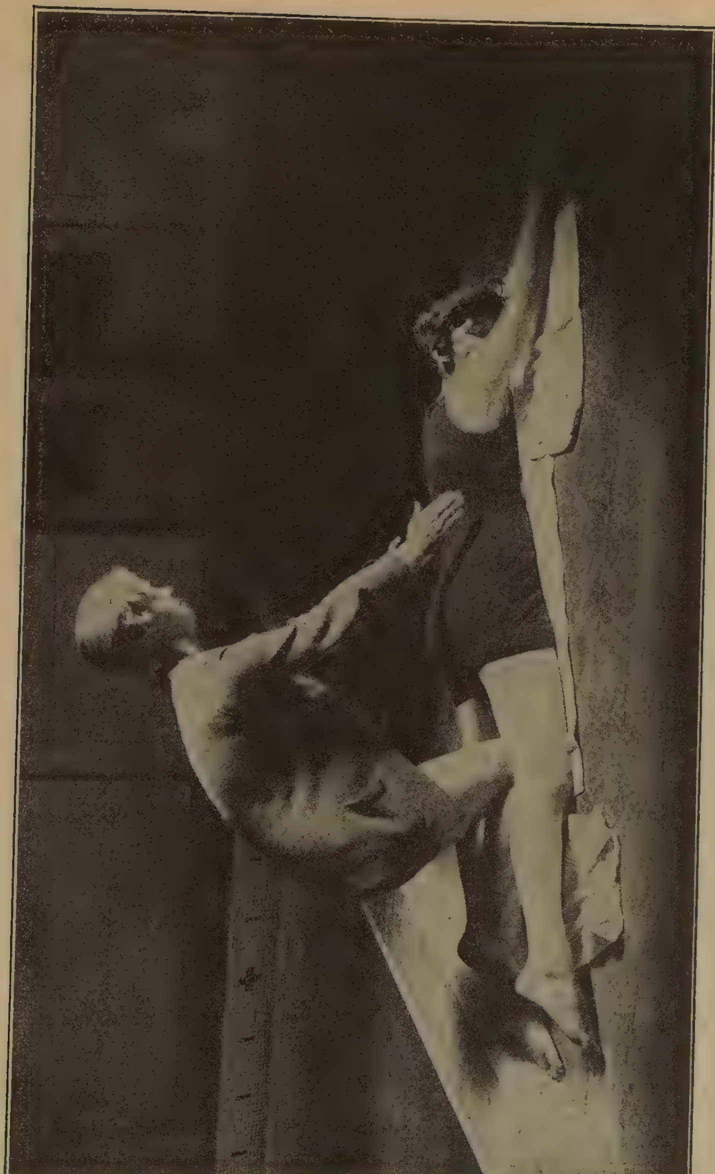

Fig. 166.—Artificial respiration. The hands approaching the victim's chest.

FIG. 167.—Artificial respiration. Second position. The hands, with the weight of the body behind them, pressing firmly on the chest.

back. If possible he should be held upside down and slapped on the back. Not infrequently the substance has already been removed, leaving irritation which suggests that it is still there.

Common accompaniments of accidents are fainting, shock and unconsciousness. Either may occur also under other circumstances than accident.

Fainting (syncope) consists of a temporary anemia of the brain. It is to be treated by placing the individual in a position to restore brain circulation—that is, lying down or with the head hanging down. In syncope the face is usually pale and the body relaxed. Consciousness may or may not be lost. If the individual is in the proper position and has plenty of air, it is seldom necessary to do anything else to restore him, although aromatic spirits of ammonia may be given if he is conscious. Fainting is apt to occur when extremely painful injuries are received; but it occurs in other circumstances, sometimes apparently by habit, sometimes for psychological reasons, and sometimes because of weakness, malnutrition, or exposure to warmth and bad air. It usually has no significance in respect to heart disease.

Shock consists of a pronounced depression of the system, in which the vital functions tend to stop. Death may result unless stimulants are used. It is the accompaniment of extremely severe and painful accidents. Its treatment, so far as the layman is concerned, is much the same as for fainting, but medical attention should be secured, both for the injury and for the state of shock itself. Sometimes there is no external or visible injury to account for the shock, in which case an internal injury may or may not be present, or the condition may be due to the psychological effect of the circumstances.

Unconsciousness associated with an accident may be of either of these two varieties, syncope or shock. The only other common cause of unconsciousness is epileptic seizure, in which case there are usually other symptoms. The body may be rigid and twitching, and the color livid instead of pale. Nothing need usually be done, aside from keeping the individual quiet in the recumbent posture until recovery is complete. Something may be placed between the individual's teeth to prevent biting of the tongue. Medical attention should be

secured if possible. The cause of a convulsion should always be investigated. One who observes a convulsion should report it either to the individual or his family, for the individual himself may not be aware of its having occurred.

Since most trauma is due to accidents, the prevention of trauma is largely the prevention of accidents. This is a part of personal hygiene. The prompt and proper treatment of minor accidents is a measure for the prevention of serious harm from them, but it is not a part of personal hygiene, but of medicine. Whenever possible, accidents should be treated by physicians. Those who treat their own minor injuries should realize that they are carrying out medical procedures, and should acquire the knowledge of the correct method. Beyond the few measures that have been mentioned, it is usually not safe for laymen to assume responsibility.

The prevention of accidents is an important part of public health. Regulations regarding traffic of all kinds, and regarding procedures involving machinery in industry, and regarding fire prevention have resulted in some slight diminution in the number of certain kinds of accidents. They are still appallingly common, however.

Personal accident prevention involves very largely the matter of skill in the use of the muscles. Awkwardness is responsible for many accidents, ranging from pin pricks and cuts to dislocations and fractures. Accurate neuro-muscular coördinations should give a degree of grace and precision in all movements that would markedly reduce the frequency of the damage of the body by trauma.

CHAPTER XXIV

TUMORS

Interpreted literally, the word tumor means swelling. But not all swellings are tumors in the sense in which laymen understand the word. Swellings occur in inflammation, for example, but they are not tumors. Technically a tumor is known as a neoplasm, or "new growth;" that is, a growth of tissue locally beyond the usual amount needed to keep a tissue in health or to repair it, such tissue having no physiological use.

Laymen are likely to consider all tumors as dangerous and perhaps fatal. This is not the case. There are benign or harmless tumors; and malignant, harmful, often fatal tumors —a large group of which is known as cancer.

Tumors may arise in almost any part of the body. Often, for no obvious reason, an organ or a tissue begins to produce more than the usual number of cells, and to increase in size because of the increase in cells. Sometimes the increase in size is very slight, however, because only a small area of tissue is involved.

The benign tumors usually do no particular harm, but they may interfere somewhat with the healthy functioning of the organs in which they are located, or mechanically interfere with the circulation and nutrition of organs near by, if they are large enough to exert considerable pressure on them. Sometimes even benign tumors must be removed for these reasons. They do not usually recur after removal, and the individual's general health suffers little if at all. Some few of these benign tumors tend to degenerate into malignant tumors, and, to prevent such an occurrence, often must be removed.

Malignant tumors, however, interfere with general health quite early. They tend to invade and destroy surrounding tissue. If not thoroughly removed at an early stage, they

cause death. They also often tend to recur after removal if the removal is not complete, and to appear in other parts of the body.

The benign tumors are classified according to the tissue from which they are formed. For example, a lipoma is a tumor of fatty tissue, and an osteoma, of bony tissue. Red birth marks are benign tumor formations of blood vessels. Adenoma is a benign tumor of glandular tissue, and may be found in any glandular organ such as the thyroid or the breast. Cysts and warts and moles are common sorts of benign tumors. None of these tumors should occasion any alarm at all, after they have been pronounced benign by a physician. It is well to have them examined from time to time, however, especially if they undergo any sort of change.

Fig. 168.—Cancer of the cervix of the uterus.

The malignant tumors are of epithelial tissue (cancers); or of connective tissue (sarcoma). Either may be found almost anywhere in the body. Cancers are particularly likely to occur in the uterus, the breast, the stomach, and on the lips and tongue.

The cause of tumors is not yet known. Much study is being given especially to cancer because of its seriousness and prevalence. It is not inherited. Because it is so frequent, cases will be found in most families, but there is no proof of its being hereditary in man or even of its having a tendency to be hereditary. Nor is cancer contagious. Nor is it related to so-called constitutional or "blood" diseases. After it has gone on for a time the constitution suffers, but the cancer itself is local in the one or more places where it is found; and is not due to constitutional conditions preceding it, so far as is known, but to local causes.

Cancer occurs most frepuently in those parts of the body that undergo changes in function from time to time (as the

mammary glands or uterus); or in parts of the body that are subject to mechanical or thermal or chemical irritation (such as the lip, which may be irritated by a rough tooth, or the cervix of the uterus, which may be irritated by chronic discharges). A sudden single blow or injury probably is never the cause, although a chronic slight injury seems often to be. Cancer is largely a disease of middle life although it may occur earlier, some forms even occurring in youth.

The prevalence of cancer is thought to be increasing. Certainly more cases of cancer are reported, but this may be

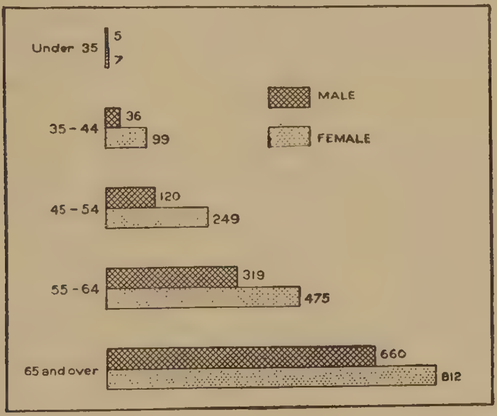

FIG. 169.—Mean annual mortality from cancer in the two sexes at different ages, registration area, 1915–1919. Rates per 100,000. Adapted from a graph issued by the Prudential Insurance Co. of America. (From Moore, "Public Health in the United States," Published by Harper & Bros.)

because medical and surgical diagnostic measures are better, so that more cancers are recognized. The American Society for the Control of Cancer reports that, whereas the deaths of United States soldiers during the war were 80,000, there were during the same period in the United States 180,000 deaths of cancer, or a total of one out of ten persons over forty years of age.

To prevent this large number of fatalities from cancer one thing especially is necessary—the early diagnosis and prompt, thorough treatment of cancer. A cancer cannot be diagnosed and treated early enough to cure it unless individuals have

medical advice early about all swellings. Because of the difficulty in determining what are benign tumors and what are malignant ones, and the impossibility of this decision by laymen, it is necessary to have the best medical advice available regarding any tumor-formation in the body. In women lumps in the breast need special investigation. Often they are quite harmless, but often also they may need removal. Cancers that arise in the hidden parts of the body (such as the stomach or uterus) and cannot be seen or felt by the individual, may progress to a considerable degree unless some symptom suggests that something is the matter and the symptom is investigated. Any persistent indigestion, or any chronic discharge from any part of the body should have attention. Discharge from the vagina is especially significant in women of middle age.

All chronic sores on the mucous membrane or on the skin should also receive medical examination. So also should any area that, while not actually a sore, is constantly or presistently irritated, especially such areas on the tongue or lips. Any part of the body that occasionally bleeds should be examined. In women any bleeding except the normal menstrual periods—such as a slight bleeding between the menstrual periods or excessive bleeding at the period, or the recurrence of bleeding after menstruation has ceased at middle age—should be investigated. Bleeding hemorrhoids at the anus should not be neglected, for cancer is quite common there. Warts and moles are benign tumors, but if they become irritated, or change in any way, they too should be investigated.

Pain is not a common early symptom of cancer. If one waits for pain, disregarding the earlier signs mentioned, the chances of recovery are quite small. Almost any prolonged symptom of disorder of any organ may have grave significance. It is not fitting that ill health of any kind be borne. While bearing it a person may have in mind all the serious possibilities and go through much mental anguish because of apprehension. It is far wiser from every point of view to get the matter cleared up as soon as one observes faulty functioning, in order to rid the mind of an unnecessary fear, or to have the proper treatment if any is needed. The fear of cancer is almost a disease

in itself. It is quite unlike the calm recognition of abnormalities and the discriminating care of them.

If the symptom that sends one to a surgeon for examination seems to him to indicate a suspicious condition, and he advises operation or X-ray or radium, the advice should be acted on promptly, since a large number of early cases, that have treatment without delay, make complete and lasting recovery. Operations are often done when there is merely a strong suspicion of trouble, in order to give the patient the benefit of the doubt.

Fake cancer cures in large numbers are on the market. The public, believing cancer incurable, or seeking an easier way than operation, may use these false methods until it is too late for scientific measures to be successful. Cancer is not necessarily incurable at all stages, although it usually is incurable after one has been the victim of quack cures before accepting the approved methods—X-ray, radium or surgical removal.

PART IV

HYGIENE

CHAPTER XXV

POSTURE AND BODY MECHANICS

There are given ways in which any mechanism may be used to the best advantage, so as to produce the most effective action of the mechanism and the least damage to the mechanism itself. The body is, from one point of view, a mechanism. It consists of weights variously distributed in respect to levers, with muscles that constitute the power, and joints that, as they are moved, permit the redistribution of weight.

Every move made by the body involves a principle of physics. Skilful movements are so made, according to the particular principle involved, as to use the least possible amount of energy and produce the least strain on the structures used. Some individuals never learn even to write without having to strain the muscles to overcome the mechanical inertia associated with the poor use of the mechanism. It is not surprising that such intricate mechanical procedures as standing, walking and sitting should so often be badly performed. That they are difficult is shown by the length of time it takes a child to learn to perform them.

Because one can do these things and does do them habitually, it need not be concluded that they are being done correctly. At least nine out of ten individuals are making much more work of them than is necessary, and at the same time interfering with the body health by doing them badly. The maintenance of correct posture requires skill, and often must be deliberately learned.

The body is so built that if it is properly lined up less effort is necessary to hold it in its best position than in any wrong position, and less strain is produced in so doing. The first element in correct posture is the securing of the normal relationship of parts of the ~~body to each other, so that~~ the body

will, as nearly as possible, balance itself. This involves establishing a center of gravity, so that the whole weight of the body falls directly on the weight-bearing area below. If any part of the body is off-center, just to that degree must

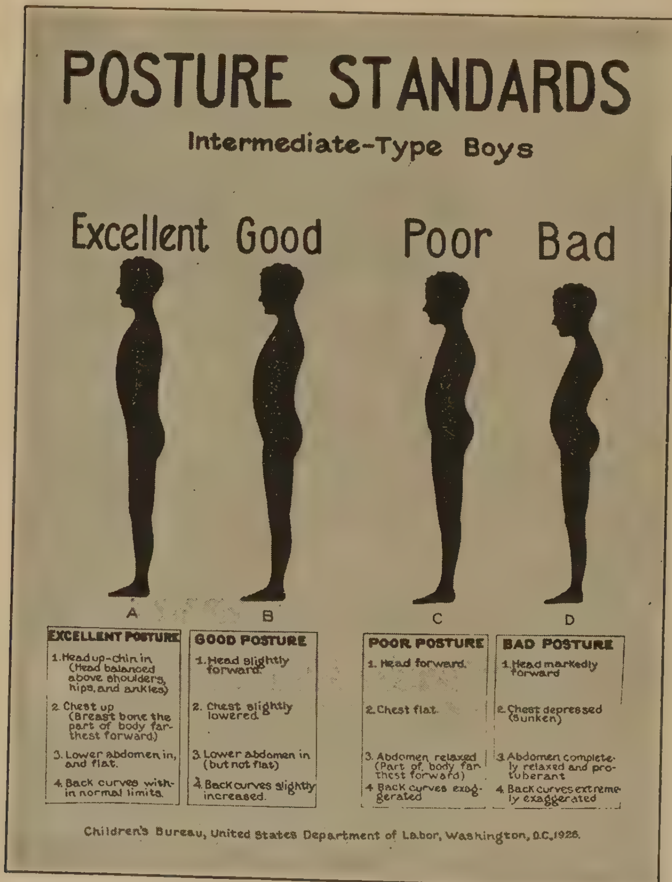

Fig. 170.

some other part be held off-center to balance it, and to that degree will strain result.

In standing and sitting there should be a center of gravity running straight through the body; and in walking, a center

of gravity that is constantly moving from one weight-bearing leg to the other. It should be noted that the spinal column is not a straight column and that the organs are not all placed in the exact middle of the body. Nevertheless the body is so planned that even with the spinal column curved, the organs off-center, and the legs set into the hips at an angle, a center of gravity may be established quite easily by the use of the muscles.

FIG. 171. — Diagram illustrating the muscles (drawn in thick black lines) which pass before and behind the joints and by their balanced activity keep the joints firm and the body erect. (From Martin, "Human Body." Courtesy of Henry Holt & Co., Publishers.)

The muscles are arranged on the front and back of the body in opposing or antagonistic sets. The body is kept from toppling forward by the muscles in the back of the trunk and legs, and it is kept from toppling backward by the muscles in the front of the body and legs. Both sets of muscles are ordinarily slightly contracted, although the tendency of the body is to flex, or bend, which makes it necessary for the extensors to work a little harder, to counteract the strong flexors.

When the body is well balanced in the standing position, the head will be directly over the feet, and a plumb-line dropped from the ear will pass through the middle of the shoulder, hip, knee and ankle. If the vertebral column could be examined in this position, it would be found not to be exactly plumb, but to curve slightly forward at the neck and waist and slightly backward at the shoulders. But these curves will not be very apparent as the individual is ordinarily observed. The back will appear almost flat, the neck upright, the head erect, the chin not protruding, the chest slightly arched in front, the ribs widespread, the shoulders down and back, the scapulæ close against the chest, the hips not protruding in back, the abdomen flat, the knees neither sprung nor over-straightened.

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Fig. 172.—Good posture.

The posture just described as good is that which has been shown in practical experience to give the best results in health, comfort, efficiency, and appearance. The impression one gets is of alertness, readiness for action, strength, grace, intelligence, and good breeding. Such posture is almost universally recognized as the mark of the high-born. Unfair

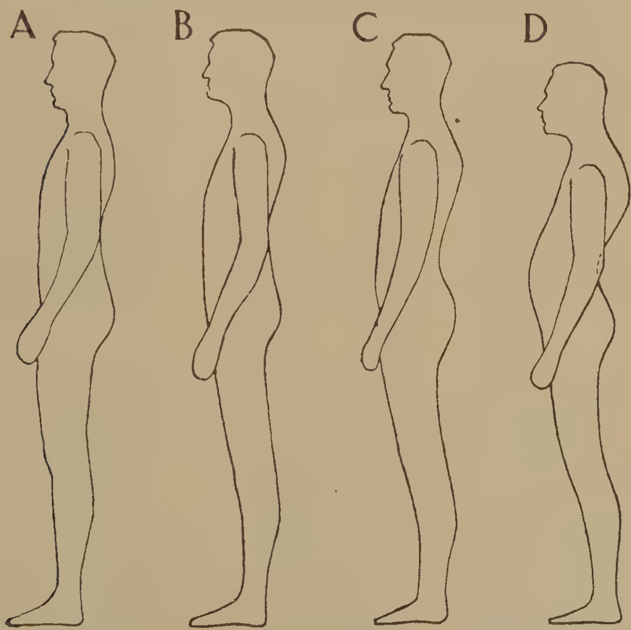


Fig. 173.—Tracings made during examination of 700 Harvard freshmen. A, 7.5 percent; B, 12.5 percent; C, 55 percent; D, 25 percent. Represent respectively: good, fairly good, bad and very bad mechanical use of the human body. (Used by permission of the Department of Hygiene, Harvard University.)

as it sometimes is to judge of nobility of birth and of character and of intellect in this way, the world is quite prone to do so.

Any faulty distribution of the body weight is likely to change the three normal curves of the spine. When one curve increases, the others usually increase in order to restore the balance. Poor posture involves most often an increase in the normal curves of the spine. Not rarely one sees a spine that has been made into one long curve, the axis of the body slanting backward at the hips in order to maintain balance, with a

short deep curve at the lower back, and another sharp forward curve at the neck. This is what was recently called "the debutante slouch" and is still seen frequently in both men and women.

The natural tendency of the upper spine is to bend forward unless the spinal muscles are used to hold it constantly erect. But the spine supports at the top a heavy part of the body, the head. If the head is held ever so little forward the spinal muscles are stretched a little. The next step is a definite curving forward of the whole upper spine, with a simultaneous sinking in of the sternum and dropping forward of the shoulders. At the same time the ribs slant more sharply downward, both where they are attached to the spine and to the sternum. This gives a contracted chest, which makes a lower position of the diaphragm necessary. The poor posture in the upper part of the body is soon followed by poor posture of the lower back. Often there is a sharp forward curve of the spine at or below the waist level to balance the backward curve above. Because the chest is diminished in size, there is a bulging of the abdomen, the organs being crowded down. For the same reason the abdominal muscles usually become stretched, which makes the bulging still more pronounced.

The first impression one gets of the individual whose alignment is not good, is that poor posture (at least when unclothed) is not pleasing to the eye. It is not pleasing in any guise to the one whose taste is enlightened. Second, poor posture suggests inefficiency and lack of readiness for action. There is the suggestion that spontaneous movement would not be easy, but that an interval of gathering the body together would be necessary before any move could be made. One also feels that the individual would be awkward, or at best lack poise and grace. Finally, poor posture suggests fatigue and weakness. If it does not actually indicate an ailing body, it indicates an imitation of it, that leads to it.

The "slouch" posture was adopted (unconsciously to most of those who adopted it) in imitation of adolescence at its worst. Those who cling most tenaciously to early youth and are willing to sacrifice a great deal to appear juvenile, find this style of carriage, with its flattened chest, convenient to mask

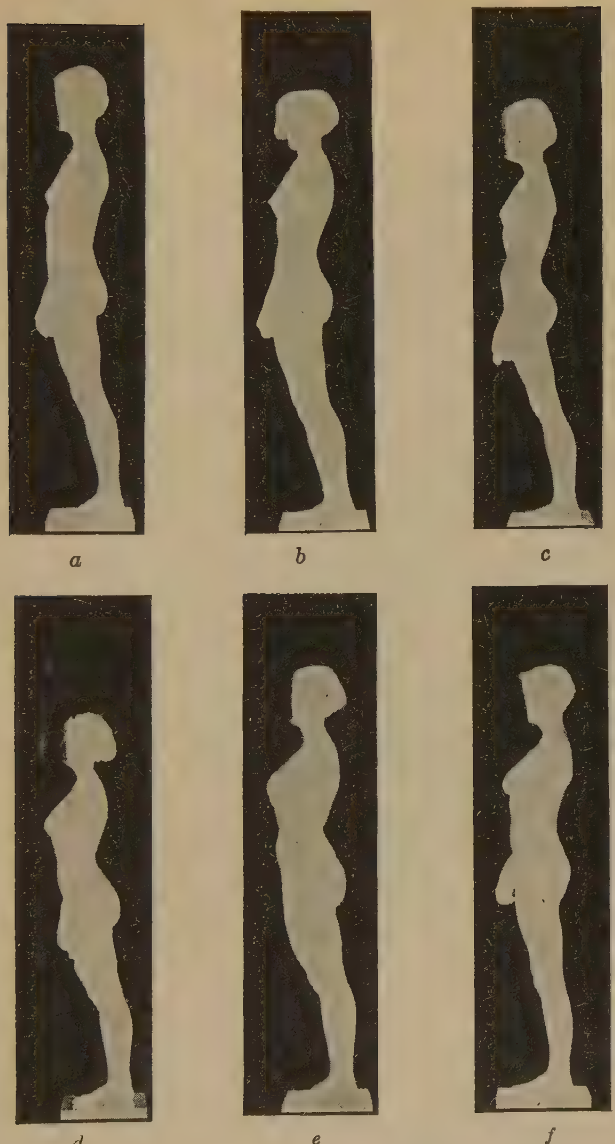


Fig. 174.—Deviation of body axis. Note also the following. *a*, axis forward from the feet, backward from the waist, flat chest. *b*, similar to *a*; round back. *c*, similar to *b*; prominent abdomen, hips high. *d*, overextended knees, increased spinal curves. *e*, similar to *d*; prominent abdomen. *f*, backward slant from waist upward.

any signs of maturity. But the posture of the ailing adolescent too closely resembles that of senescence to be either beautiful or safe. While the health is fairly good and the face is young, a bent back may be discounted, but when youth is really gone, such a deformity will make youth appear still farther in the past.

Fig. 175.—Round back and prominent abdomen of old age. (From Jones & Lovett, "Orthopedic Surgery." Courtesy of William Wood & Company, Publishers.)

There are various explanations of the beginning of poor posture. It seems logical to suppose that the disturbed equilibrium often begins at the top, with a forward carriage of the head, and that the other changes are dependent on that change. Probably the initial bad habit is often not only allowing the head but the neck and upper spine to fall forward, in which case the bad results would appear still more quickly. There are many contributory causes of the initial loss of alignment. One of the most frequent is a weakness of the muscles at a time of malnutrition or of convalescence from illness. At such a time the body finds it easier to allow the head and shoulders to fall forward and the chest to sink in. The slight unconscious muscular effort usually performed fails to be performed unless attention is given to it. Frequently the skeleton grows rapidly in adolescence and the muscles may fail to keep pace with it, unless the habits of exercise and nutrition and sleep are good.

School seating is often blamed for starting poor posture. It is probable that it is often a contributory factor, if the seats and desks are so arranged as to cultivate a tendency to bend the

head and neck forward. Nearsighted children frequently show most pronounced poor posture. The clothing of children may also have a bad effect, if it is arranged so as to drag the outer ends of the shoulders forward and thus eventually to lead the whole upper back to bend forward. Clothing that binds

FIG. 176.—Poor posture in adolescent boy. (Lovett "Lateral Curvature of the Spine.")

too tightly about the lower ribs may cause the chest to be compressed, the sternum to sink inward, the shoulders to fall forward, and the back to bend.

Throughout life, when fatigue is great, or the body is weak, the slight additional muscular effort needed to keep the head and spine erect is often not made. It seems restful to allow the body to sag and the posterior muscles to relax and stretch

a *b* *c*

d *e* *f*

FIG. 177.—Flat chest. Note also the following. *a*, very round back, deep lumbar curve, axis slanting backward from the waist up. *b*, round shoulders, axis forward from the feet to the waist, and backward from the waist up. *c*, neck forward. *d*, chest very flat, neck forward, axis forward from the waist up, prominent abdomen, overextended knees. *e*, chest very flat, round shoulders. *f*, chest compressed antero-posteriorly at the level of the diaphragm.

as much as they will. But when, after such a period of illness or malnutrition or over-fatigue, the effort is again made to hold the body erect, it will be found that the muscles have not

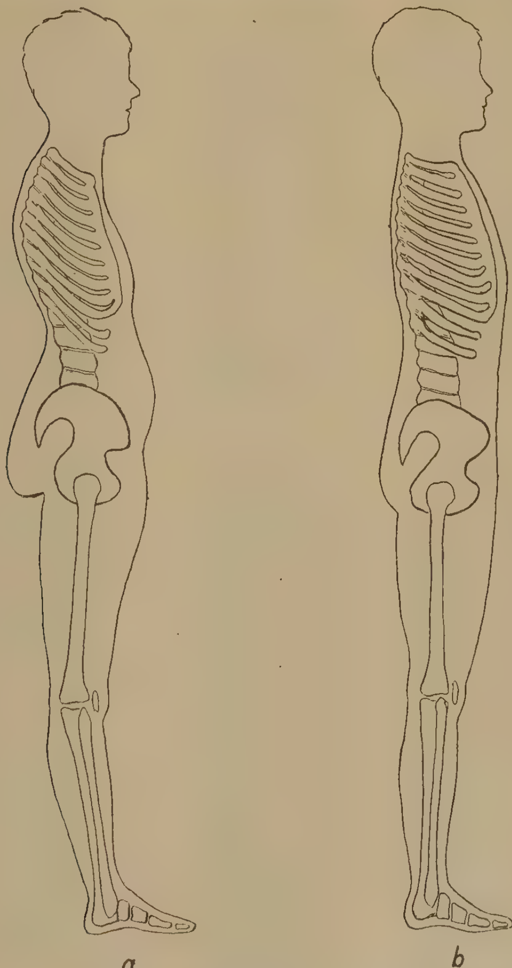


FIG. 178.—The skeleton in poor posture, *a*; and in good posture, *b*.

gained from their rest, but have become weaker and must work harder than before—in fact, must be re-trained to exhibit their original power. Since this requires an effort,

many individuals fail to accomplish it, and even early in life show changes in the skeleton, the ligaments, and the muscles, such as are often, although not necessarily, found in the aged.

Particular attention should be given to conditions that may lead to "slumping," so that the bad habit shall never be established and never have to be overcome. What is originally a bad habit is finally the foundation of ill health. A vicious circle is established; ill health—poor posture—poor posture—more ill health.

The results of poor posture, as has been said, include effects on the bones and joints themselves. It should be borne in mind that the skeleton is a modifiable structure in youth, and to some degree throughout life. Ossification of bones is not complete until the twentieth or even the twenty-fifth year, or even later. Up to that time the skeleton will not stand strain without danger of harming the bones. The bones are particularly likely to be affected by pressure and by faulty attitudes.

Continued changed relations of bones to each other also give changes in the joints, and the ligaments that hold joints together. While these changes are occurring, and after they have occurred, the muscles are strained in their tiring and painful efforts to keep erect a skeleton that is out of alignment. The strain is the same in quality, although less in degree, as that which would arise from walking about with the body bent double.

The changes in the joints are often quite marked. A considerable degree of inflammation and pain may result when a joint is continuously strained by malposition. The harm of a sudden sprain of a joint is recognized, but that similar, although at first less severe, results may follow a prolonged slight strain is not so well recognized. Many joint pains and weaknesses are due solely to perpetual strain from poor posture. Any joint in the body may be so involved.

One of the common joints where strain is felt is that between the sacrum and the ilium. The stability of this joint depends on the tone of the spinal muscles and ligaments, for it is not constructed so as to get much bony support from beneath.

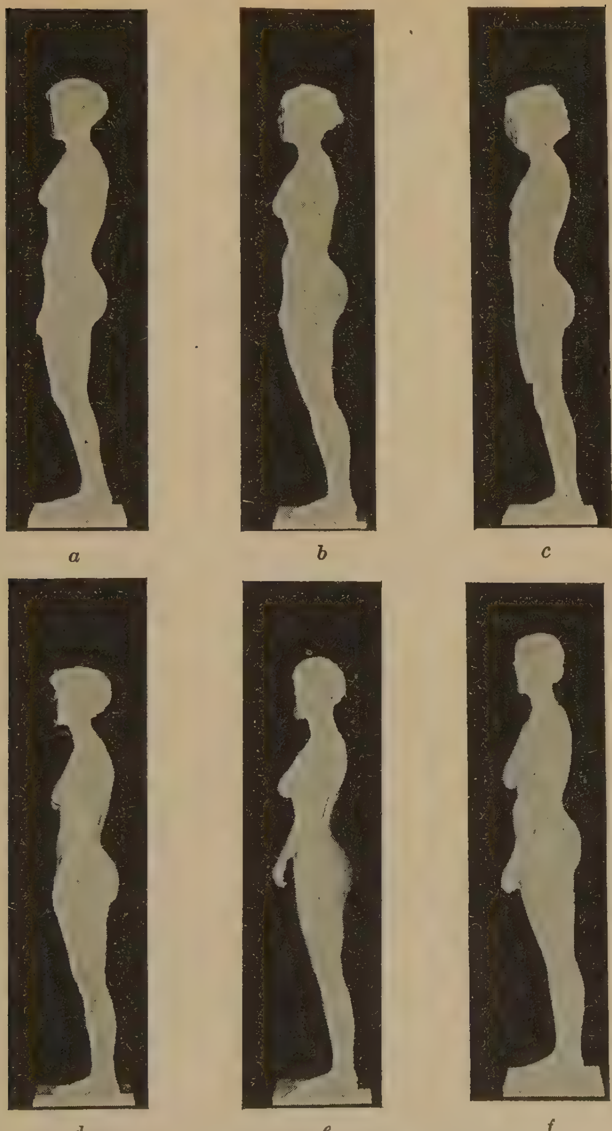


Fig. 179.—Exaggerated lumbar curve. Note also the following. *a*, round back, flat chest, prominent abdomen, axis of body slanting backward from the waist up. *b*, prominent abdomen and hips, round shoulders. *c*, round shoulders, very flat chest. *d*, round back, very flat chest. *e*, round back, hips high at the back. *f*, round back, very flat chest, prominent abdomen.

Strain of this joint is often due to a general settling of the body that increases the lumbar curve. The pelvic bones tip forward so that the hips are raised at the back, and protrude more than usual. Sometimes this is due to an increase in the size of the abdomen, the curve of the back being produced in order to balance the weight in front. The defect is often, however, merely the result of the slumping posture. First, the muscles relax, then the ligaments; finally the sacrum slips forward and downward a bit, away from the hip bones. Pain usually results at the joint. Much of the pain called lumbago, rheumatism or neuralgia originates in this way. Sometimes the nerves to the legs, that pass over this joint, are pressed on, and pain in the legs results. The joint between the last lumbar vertebra and the sacrum may also be relaxed. Sometimes it is necessary to use a support for these joints for a time, in order to relieve the pain, and allow the muscles to regain their tone and holding power, and the ligaments to tighten.

Although the effect on bones, joints, ligaments and muscles is sufficiently objectionable, poor posture would not be the very serious matter it is if it were not for the effect on the organs of the body, and the circulation through the body. Perhaps the latter effect is the most important of all, since it conceivably, and often actually, affects every cell in the body.

The faulty circulation results mainly from the cramping and crowding of the chest. When the chest flattens and its capacity is decreased, both the lungs and the heart are prevented from acting as freely as they should. The heart often sags to a lower position than usual. "Dropped heart" was a frequent diagnosis in soldiers in the recent war, accounting for many annoying symptoms of poor heart function, such as fainting, rapid heart action, breathlessness, chest pain, and other effects of poor circulation. The diagnosis implied no organic heart disease, but those who suffered from it often were more incapacitated than many who had heart disease. It is being increasingly recognized that a vast amount of circulatory trouble and functional heart trouble are due to faulty and cramped position of the heart.

Further difficulty with the circulation is due to the less complete action of the lungs, and the lowering and reduced

mobility of the diaphragm. By the action of the lungs and the diaphragm in respiration, suction is exerted on the blood in the large veins, whereby it is aided in rising against gravity on its way to the heart. Since a rapid return of the blood is very important to good heart action and good circulation, it will be seen that the effect of poor posture on the action of the lungs and diaphragm is almost as important as the effect on the heart itself. The effect on the health of the lungs themselves has also been said to be deleterious, leading to a state of non-resistance to infection, although this is far less important than the other effects mentioned.

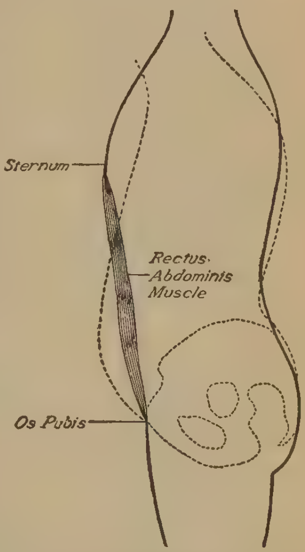


Fig. 180.—Diagram of good posture showing well-developed rectus abdominis muscle in tonic contraction; dotted line showing poor posture with relaxed and flabby abdominal wall. (From Williams, "Healthful Living." By permission of The Macmillan Company, Publishers.)

The effect on the abdominal organs is produced partly by their being crowded downward when the capacity of the chest is decreased and the chest contents therefore pushed downward. Impaired function of the abdominal organs is also partly due to the limitation of breathing and the reduced action of the diaphragm. Normally when breathing is unrestricted the diaphragm should rise and fall a good deal, and exert a considerable massage effect on the abdominal organs, improving their circulation. Finally, the abdominal organs suffer because of the relaxation of the abdominal muscles which accompanies a drooping posture, allowing a still further sagging of the organs. Furthermore, as the abdominal organs sag, they press upon the pelvic organs and interfere with their function, leading to many disagreeable symptoms. Finally, since the nutrition of the spinal cord and its nerves depends somewhat on the nutrition of the spinal muscles, it is thought that the thoracic, abdominal and pelvic organs also suffer from

faulty nerve supply when the spinal muscles have lost their tone. It is known that visceral nerve bundles may be definitely disturbed in their action by the cramping of poor posture. These combined factors affect the organs so extensively that, for numerous reasons, they could not be expected to function normally.

It is not surprising that it is quite generally agreed that the best health is not compatible with faulty mechanical use of the body. In middle life, if not in youth, the strain of muscles and joints begins to tell, and body functions to fail. Even in the very young, however, there may appear symptoms indicating the derangement of the functions which have been mentioned.

One of the earliest symptoms is often an amount of fatigue out of all proportion to the work done. Of course this may indicate many other possible disturbances, but in very many cases there exists a tendency not to use the body mechanically correctly. In any case it is customary to find that whatever ailments are present, they are to some degree improved by improving a faulty carriage, because of the associated improvement in the circulation through the organs where the ailment occurs.

It should be noted that the posture may be very poor, and may be causing serious disturbances of the health, without causing any pain in joints or muscles.

Poor posture is equally common among men and women. Statistics from the Army records showed that postural defects were the most frequent defects of all. Special measures were taken in reconstruction battalions to train those who were sufficiently near to normal to be acceptable for service. Statistics from both men's and women's colleges also make it evident that only a very small percentage of individuals know how to carry themselves properly. Only 7.5 per cent of men in a college group recently examined had good posture.

Fortunately posture is subject to great improvement in most young adults, although the ill health that often accompanies it makes the task harder. Sometimes it is necessary to get the health in better condition by means of more rest and exercise and food before the muscles can cope with their

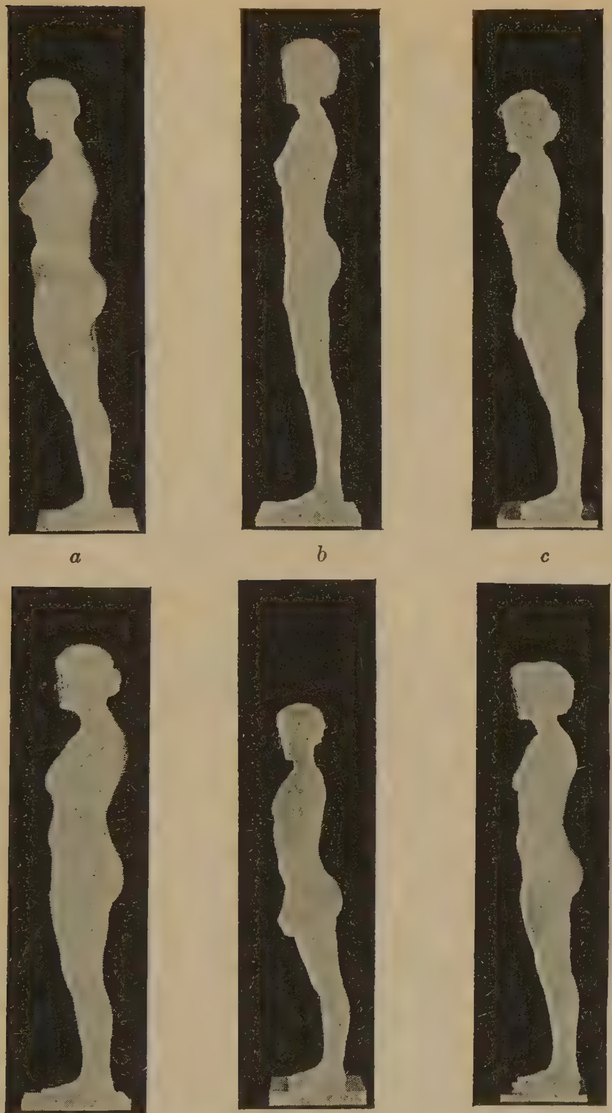


FIG. 181.—Some common postural defects. *a*, "dowager's hump" at the seventh cervical vertebra; prominent abdomen. *b*, "dowager's hump" in a thin subject. *c*, tilting of the pelvis, giving high, prominent hips. *d*, head thrust forward, round back, prominent abdomen. *e*, overextended knees, trunk arched forward. *f*, very round shoulders, head forward, chest flat, abdomen prominent.

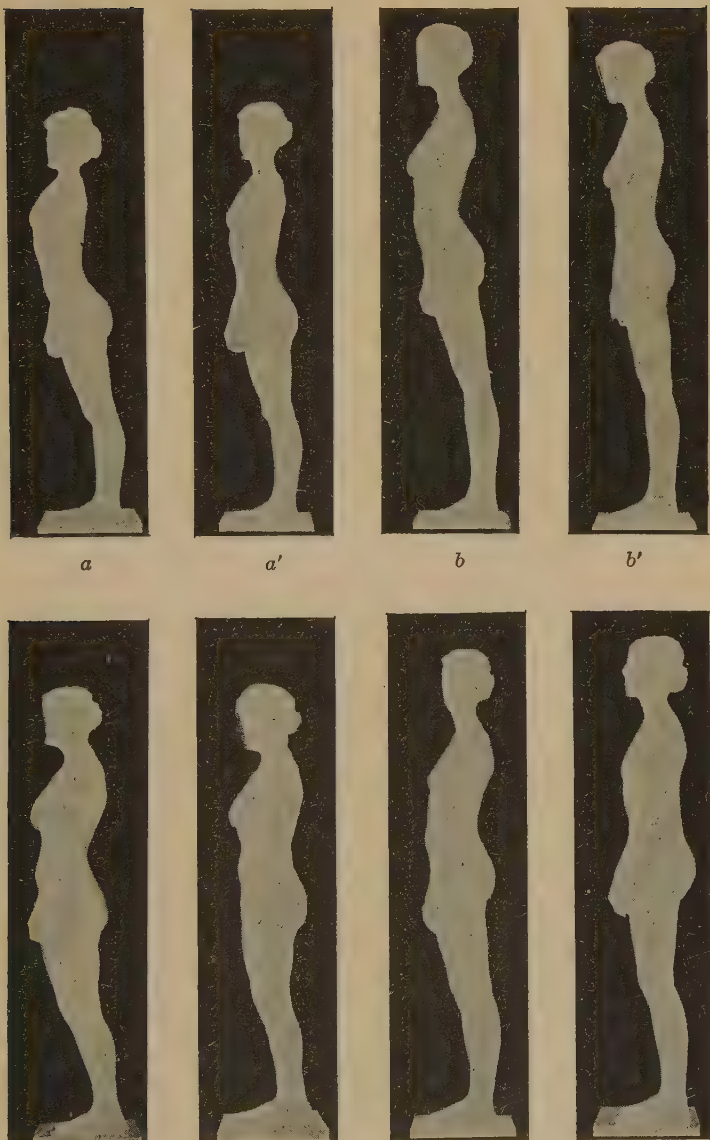
difficulties. Sometimes a chronic infection must be cleared up before nutrition can be improved.

But parallel with these efforts, an effort must be made in the direction of the proper lining up of the body, for its improper alignment may be the main condition that keeps the health under par. Often some outside assistance in the way of braces or supports may be temporarily needed to give the start in the right direction, in order that the concurrent muscle training may be able to accomplish the desired results.

Even in young people the ability to correct the posture when shown how to do so, varies a great deal. There are those who are able to use the necessary muscles very little, and those who can use them, but do not do so habitually. It is not uncommon to find a student whose posture rating is excellent or good, but—who goes about her work in poor or only fair posture. Of course it is only a matter of time until such a person loses the ability to assume the better posture voluntarily, even under inspection. It is usually the slim, flexible type that shows such wide variations, slumping being for this type all too easy. The more solidly built individual may acquire an equally poor posture, not quite the same defects appearing as in the slim type, but the defects remaining more or less constant. There is not much difference between the two types in respect to the possibility of lasting improvement.

In beginning an effort for the erect posture, it is desirable to study a profile view of the whole body in the natural posture. For this purpose either a photograph is necessary, or a view of one's self in a double or triple mirror arranged so that no twisting of the body is necessary in order to see the whole back. One should look at the profile, to determine whether there is deviation of the axis of the body or increased spinal curves, or a hollow chest or a bulging abdomen. By standing so that the back is seen flat, one should also look for curves from side to side, and elevation or depression of either shoulder or hip. The slight lateral curves may not easily be seen unless an examiner has made marks on the back over the spinous process of each vertebra.

After these defects, or any others, have been observed, an effort should be made to correct them by the use of the muscles.



a a' b b'

c c' d d'

Fig. 182.—Improvement in posture after one year's effort.

FIG. 183.—Improvement in posture after two years' effort.

If one has in mind, or before one, a picture of good posture, the effort will be easier. It will be still easier if an examiner is present to point out in which direction the greatest efforts should be made. After the correction has been made, the corrected posture should be held long enough for one to get the "feel" of it. It is necessary to know, by means of sensations from muscles and joints, when the body is in the position it should be. Thereafter the correct posture should be assumed as often as one can remember to do so. After it has been fully learned it will be found easier to maintain, and will finally become easier and less fatiguing than a former cramped attitude.

Good posture, either in standing or in motion, is never stiff. Any correction of posture that feels rigid and uncomfortable is likely to be incorrect, although at first there may be some awareness of using muscles that are weak and need strengthening. This will be particularly apparent in the extensor muscles of the back and neck. While in correct posture, breathing should proceed easily; and there should be free action possible at all of the joints. Some persons fear to carry themselves erect lest they appear "strutty" and assertive. But this only happens when the carriage is rigid, suggesting rigidity and unyielding qualities in the personality. The lean, rangy type is always more mobile than the compact, stocky type; but in all types there should be easy, unrestricted and elastic motion throughout, within its natural limits. Whatever motions of the body are performed, the muscles all through the body should be used. Those who can stand well often walk in such a way that every joint is at a disadvantage, from toes to cervical spine. The result is a lurching, jerky, fatiguing gait.

There are several devices that may be practised in order to attain good alignment of the body. One may, for example, imagine one's self suspended from the ceiling by the upper back part of the head. A jointed object that is suspended from above tends to take a more perpendicular position than one that is braced from below. Children are often taught to place the feet in a given position, to straighten the knees and the back, and hold the head up. Building posture up from the

FIG. 184.—Good posture.

feet, so to speak, is likely to produce a rigid result, with hampering of free breathing and of free use of joints.

a *b*

Fig. 185.—Testing the flatness of the back against a flat surface. *a*, exaggerated spinal curves; *b*, normal spinal curves.

One may also practice leaning against a flat wall and trying to get as much of the back as possible in contact with the wall. In a plump person, the back at the level of the waist cannot be

made to touch the wall unless the feet are moved out from the wall a few inches or the knees are slightly bent. In facing the wall, when toes and chest touch, the other parts of the body should clear—the nose by at least an inch and a half.

When the alignment of the body is correct, there are fewer bulges forward and backward. The face will not protrude forward, nor will the abdomen; and the shoulders and the hips will not protrude backward. One may practice getting into such a position as to be able to pass through a door open as little as possible. In faulty posture the door will have to be open inches wider than for the same individual in correct posture.

Any efforts at posture correction should be accompanied by efforts at contracting the abdominal muscles and widening the lower chest. If the abdominal muscles are held firm, the organs are pulled back and up. In order to make room for this correction the body must be widened at the waist and just above it, as it is intended to be. A narrow waist and lower chest is not normal. Frequently the abdominal muscles cannot voluntarily be moved at all at the first efforts, but in a few days, in a persistent individual, they come under the control of the will; and thereafter may be strengthened. In contracting the abdominal muscles there should be no drawing in of the breath nor holding of the chest rigid. If the abdominal muscles are really being used, breathing and talking go on quite naturally during their contraction. These muscles are better off if they work all the time. They need no rest except what they get during sleep, for when they are resting with the body upright, they are stretching and becoming weak.

The angle made by the sloping away of the lower ribs from the sternum in some individuals is a very acute one, but it should be nearly, if not quite, a right angle. It is possible to feel this angle. While pulling in and up with the abdominal muscles an effort should be made to widen it. Sometimes the size of the chest in breathing can be increased only from front to back. It should widen as well as deepen somewhat at each respiration. Although respiration is an involuntary matter, the muscles of the chest are under voluntary control within limits and may be trained to expand the chest throughout at each breath, and to increase the customary depth of respira-

tion. In order to be sure that the commonest type of defect in breathing is not present, one may place the hands on the lower chest at the sides, and observe how much the hands move apart at each breath. An effort should be made to make the chest motion here as great as possible. Frequently those who pride themselves on their great chest expansion may show an increase of as much as four inches when measured by a tape under the arms, while the lower chest may scarcely move. Although it matters little from the point of view of the lungs, expansion at the lower level, and the associated width of the chest at that level, is far more important than that at the upper level from the point of view of body mechanics and general health.

Children who are beginning to show a forward curve of the upper back and round shoulders are often told to "throw back the shoulders" and to "stand up straight." If the latter advice were given alone, and were insisted on, the results would be better than they are when too much attention is focussed on the shoulders. The primary difficulty is in the back and the chest. The shoulders droop because the back droops and the ribs droop. In straightening the spine and raising the chest, the shoulders will fall back into their normal place.

One may get the "feel" of the shoulders in good position by filling the lungs with air and "standing tall." If any attention need be given them at all, they should not only be pushed back but also down. The result of prolonged stooping posture is often a shortening of the muscles from the shoulder to the chest in front, so that the shoulders do not fall as they should when the spine and chest are held normally. Special exercises must often be used, and perhaps a brace worn for a time, to encourage progress.

The term "curvature of the spine" sounds as though it were more serious than ordinary postural defects. Yet many curves from side to side, which are what is meant by "curvatures," are of little significance compared to curves from front to back. They sometimes represent deformity due to disease, but they often represent only a bad habit, which may be corrected by exercise designed to get the vertebrae lined up properly and to

hold them there. Although in more pronounced cases braces may be required for a time, ordinarily strengthening of the spinal muscles and learning to "stand tall" is all that is needed.

The effect of corsets on posture need hardly be mentioned at the present time, except to be recommended for use in some

FIG. 186.—Scoliosis, or curvature of the spine. (Lovett.)

cases of relaxed abdomen. They should not, however, be used merely to disguise a bulging abdomen, but in order to give a little support while the defect is being corrected. While they are being worn, they should not be relied upon to do all the work of the abdominal and spinal muscles, but a simultaneous effort should be made to train the muscles themselves and to use them constantly, even inside the corset. Much of the

bulging of the abdomen is due to relaxed muscles and sagging organs. When it is partly due to fat deposits, the use of the muscles in regular exercise will help to correct the condition.

No one should give up corsets entirely unless she is willing to make the muscles do their work. If they are given up suddenly, and no effort made to strengthen the muscles, a considerable amount of relaxation, both of them and of the back muscles, may take place. Under these circumstances a corset or girdle should be resumed until the muscles are strengthened. Sometimes more support than that furnished by a corset is needed, to give temporary support when the health is suffering gravely because of the postural difficulty.

Undoubtedly corsets in the past had a great deal to do with giving the health of women its bad reputation. They may still be injurious if so adjusted as to push the abdominal organs downward, or to increase a forward curve of the spine at the waist level, or to cramp the lower chest.

Many difficulties of the nature of "slumping" first show and continue to be most prominent in sitting. One sits, rather than stands, when idle or when performing tasks that may be as well or better performed in that position. Comfort is an important consideration in sitting, and often it seems to be thought that comfort is only to be gained by a complete relaxation of the body. One of the most unfavorable postural habits is that of sitting on the edge of the chair and resting only the shoulders against its back. There occurs a crumpling of the body at the waist line, and a sinking in of the chest that is even more pronounced than that which occurs in the same individual while standing. It has an even worse effect on body physiological processes, if much sitting is done in this position. Those who sit a good deal particularly need to learn how to sit. The first requisite for good sitting posture is to sit squarely on the seat of the chair and to place the lower spine against the back of the chair. When at rest one should utilize the back of the chair to lean against throughout its length. If it slants too far backward, and one must get nearer one's desk, for example, the bending forward should be done at the hips, and not at the waist. The chest should be held up and the whole spine erect, as in standing and walking.

Seating in schools and industries is a matter of considerable interest, because correct chairs make the correct posture much more likely, and correct posture at work lessens fatigue and increases efficiency and general health.

The posture during recumbency is less important than in the upright position, for no body weight is being supported and there is no downward pull on organs. Nevertheless, a considerable amount of relief from faulty daytime attitudes may be obtained if one sleeps in such a way as to avoid further stretching of spinal muscles and further contraction of the chest. Whether one sleeps on the back or the side, the spine should be fully extended. Sleeping on the face with the head turned to one side necessitates having the spine straight and on that account is desirable. In no position is a pillow necessary unless it be a very small one when lying on the side. Perhaps the most entirely restful position is on the back with no pillow. Any position is permissible that does not arch the back, contract the chest and push the neck and head forward.

Structurally, the test of good posture is its correspondence to anatomical standards and its permitting of mechanical freedom in use. Functionally, the test of good posture is its effect on bones, muscles and joints, and the degree to which it aids correct functioning of organs.

CHAPTER XXVI

THE FEET

This subject involves a consideration of the correct mechanical use of the feet, their correct shoeing, and their daily care.

Attention to the mechanical use of the feet is necessary for the sake of the comfort and utility of the feet themselves; for the sake of the posture and all that depends on posture; and for the sake of the activity of the body. The latter point is often ignored. Poor feet interfere with the activity necessary to carry on one's work, and thus interfere with efficiency. Through depriving the individual of exercise, they interfere also with the general health. A considerable number of both men and women of middle age, who have given up all forms of sport and outdoor recreation, have been obliged to do so because their feet would not tolerate much use.

The prevalence of poor feet and poor shoes was first given general attention through the statistics gathered in the examination of recruits for the army during the recent war. In the Surgeon General's report on "Defects Found in Drafted Men" it was asserted that 12 per cent of all men examined had flat foot and that this cause gave 2 per cent of the total number of rejections. In an examination of infantry in 1916 it was reported that of 30,000 inspected, 21,335 were wearing too small shoes, and 3,511 were wearing too large shoes. There was a total of 73.9 per cent wearing unsuitable shoes.

Industrial employees have been found to have about the same per cent of defects of the feet, and of poor shoes. Some employers have examinations made of the feet of prospective employees, and try to have foot defects corrected, knowing that working power is decreased in many occupations by pain or disability of the feet.

Poor feet are found in all classes and at all ages and in both sexes. Young college students, even, are more likely to have

some sort of foot defect than defects of any other part of the body except the teeth.

"Flat foot" is the commonest abnormality of the foot. Sometimes it is congenital, in which case the individual may get good use of the feet, even to the extent of becoming a champion walker or tennis player. Sometimes flat foot is due to injury or disease. Usually, however, flat foot means only weak foot, the weakness being of an entirely preventable

Fig. 187.—Side view of flat-foot (right.) (From Jones & Lovett, "Orthopedic Surgery." Courtesy of William Wood & Company, Publishers.)

sort. Because the foot is weak it is both flat and inefficient. The weakness, except in the rare cases due to certain diseases, is a general weakness of all the muscles and ligaments of the foot and of the muscles of the leg that govern foot motion. Sometimes the weakness is a part of poor general musculature, such as is found in the undernourished. Weak feet are, however, often found as a part of the flabbiness of obesity, in which case the results are worse, because of the additional body weight that the feet must carry. Some weak feet do not show their weakness until the individual begins to put on weight.

Sometimes, however, weakness of the feet is not a part of weakness of the whole body, and is found in those who might have strong feet if they knew how to use them, were willing to wear shoes that would permit correct use, and were able to balance the body so as not to perpetuate strain on the feet. Very rarely do weak feet result from even excessive use of the feet in standing and walking in those whose mechanical use of the foot and of the body is good.

The ankle and foot are composed of twenty-six bones, held together by firm ligaments that help keep the bones in proper relationship to each other. This relationship is to a considerable degree maintained by the leg muscles whose tendons are attached to the foot bones.

FIG. 188.—The foot. *a*, bones, lateral view; *b*, with some of the muscles and tendons.

There are two arches formed by the bones, one from ball to heel, and the other across the ball of the foot. These arches are similar in principle to the arches of a bridge, the curves representing great supporting power for weight carried above, while permitting the springiness that enables them to withstand force applied from above. Because of the latter characteristic, correct use of the foot involves grace of motion and resistance to fatigue.

In order to determine whether there is a lowering of the longitudinal arch, one may examine the footprints after putting the foot in water and stepping on the floor. If the print is that of a normal foot, there will be only a very narrow isthmus at the middle of the foot, which will be at the outer edge. A foot with a flat arch will make an impression nearly, if not quite, as wide at the middle as at the ball and heel. In

looking in the mirror at such a foot in the standing position, the inner edge of the foot, as well as the outer edge, will be seen to approach the floor, whereas in the normal foot there will be a considerable distance from ball to heel on the inner side where the edge of the foot is well raised from the floor. The feet should be held parallel about four inches apart for this test.

In the strong, well-built foot the middle of the leg and the middle of the ankle will come exactly over the middle of the foot. In the weak foot the middle of the leg and ankle is well inside the middle of the foot. In the strong foot the prominence on the inner side of the ankle will be

A *B*

Fig. 189.—*A*. Type of tracing described as normal, with outer border touching ground. *B* Tracing of flatfoot. No symptoms in this case, foot useful. (From Jones & Lovett, "Orthopedic Surgery." Courtesy of William Wood & Company, Publishers.)

no greater than that on the outer side. A line dropped straight down from either prominence will hit the edge of the sole. In the weak foot, the line dropped from the inner prominence misses the edge of the sole entirely, and falls outside the outline of the foot; whereas one dropped from the outer prominence would have to pass through the foot—the outer prominence being almost a depression. In the strong foot, the ankle is upright; in the weak foot it is rolled over to the inner side. The adjective *pronated* is used to describe the foot whose sole approaches or touches the floor on the inner side and whose ankle is rolled inward.

A manual examination of the foot will show that there are bones at the front and at the back and at the outer side.

Along the inner margin of the foot between the ball and the heel the bones are located higher in the foot. It is only when the foot is weak that the bones in the middle of the foot, that should be higher, roll downward and give a bony margin along the inner side. In the normal foot there is a concavity there.

In the correct standing posture the weight should fall where there are bones to support it. In a strong foot this is the position in standing, the inner border of the foot clearing the ground because it is held up by the leg muscles, whose tendons are attached to the bones of the feet.

The position of the foot that produces the most stretching of these tendons is that of toeing out. In such a position it is almost impossible to contract the leg muscles strongly enough to keep the foot from pronating and the tendons from stretching.

Standing in front of a mirror, one may prove this by trying to raise the inner border of the foot while holding the ball and heel down with the toes turned out. The same effort with the toes straight ahead is much more easily successful. Habitually walking with the toes ahead makes good foot position much easier. It is the way of walking that is utilized in the army for the training of those with weak feet, and that should be used for the prevention of this defect, too.

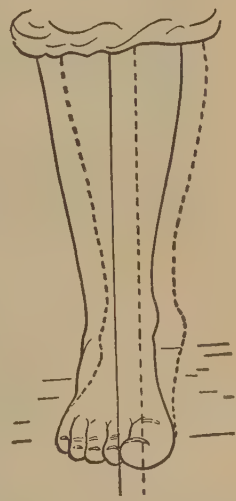


Fig. 190.—Normal and pronated position of the foot, the latter in dotted outline. (From Jones & Lovett, "Orthopedic Surgery." Courtesy of William Wood & Company, Publishers.)

The result of toeing out is not only the stretching of these important tendons that hold the foot bones together, but it may also result in disturbing the relation of the bones in the knee. Pain in the knee is sometimes the only complaint of those with weak feet. Toeing out gives strain of many muscles in order to maintain balance. Even the spine may be painful for this reason.

The tendons that hold the foot in position may also stretch in the individual who does not toe out, if he does not understand that the leg muscles, to which the tendons belong, must be used to hold the inner border of the foot, from ball to heel, off the ground. If the ankle is allowed to sag inward, the

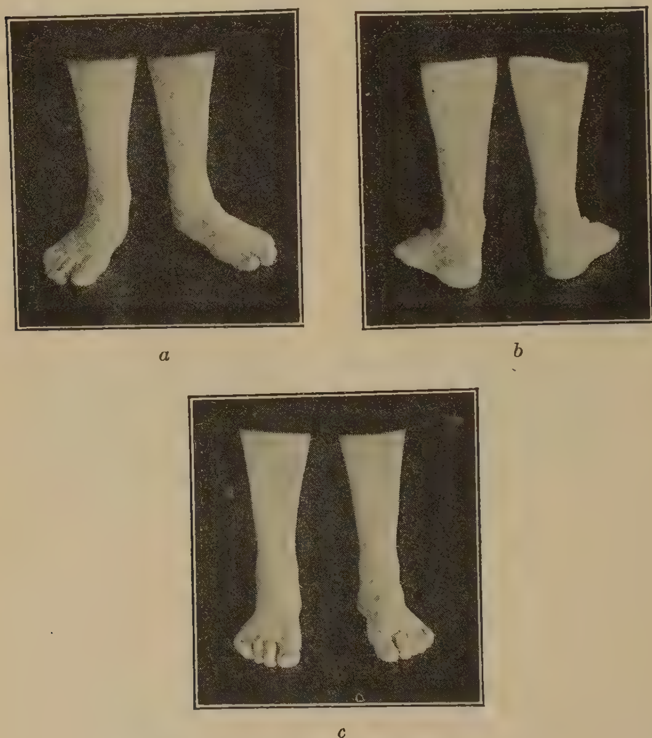


FIG. 191.—Pronated feet, front view (*a*); back view (*b*); the same feet after training (*c*). (Twenty year old girl.)

constant pressure against those tendons is certain to stretch them in time. In order to prevent this result, it is therefore necessary not to toe out, and at the same time to practice throwing the weight toward the outer side of the foot. It will then fall on the bones composing the arch and be distributed from there to both ends of the arch—the ball and the heel of the foot. This is the position that places the foot at the best

advantage, so that the muscles in the leg can be used to maintain balance with the least effort, at the same time preventing foot strain.

The strong foot shows not only a longitudinal arch, but also a very slight upward curve from side to side across the ball of the foot, called the transverse arch. This may be seen at the top of the fore part of the foot, but is more easily seen on the sole, where there should be a slight hollow at the ball. Instead, in the weak foot there is often a prominence, with usually a callus on it, made by the sagging of the bones of the anterior arch, which allows the bones to rest on the ground and to press too heavily on the skin underneath them. A callus on the ball of the foot is usually an indication of a weak anterior arch. When the transverse arch is weak the foot spreads out and becomes much wider when the weight is put on it, because of the flattening of the arch. Those who find that the feet have become both longer and wider in adult years usually have weak, flattened feet to account for it. They will also find that shoes that are comfortable in sitting are not comfortable in standing, because of the collapse of the arches, and the increase in the dimensions of the foot, under weight-bearing.

FIG. 192.—The foot prints as they should appear (*a*) and as they should not appear (*b*). (The Woman's Press.)

Relaxation of the anterior arch is contributed to by failure to use the toes as one stands and walks. The utility of the toes and of the anterior arch may be appreciated if an effort is made to get the correct posture of the foot with the toes relaxed. It cannot be done so completely when the toes are not used. This is an indication of the aid offered by the toes in maintaining balance and the correct relationship of the foot bones. In standing, position is much more stable and easily maintained if the toes are used. In walking, it is particularly important to grip with them, for they furnish much propelling power.

Frequently the toes are merely damaged appendages to the foot. Too great pressure on the ball of the foot when high heels are worn is also a factor contributing to produce a relaxed transverse arch.

Fig. 193.—Good arch. (By courtesy of Women's Foundation for Health and American Medical Association.)

Fig. 194.—Good anterior arch. (By courtesy of Women's Foundation for Health and American Medical Association.)

As has been stated, relaxation of the arches is usually a part of general weakness of the foot and could be readily prevented and fairly readily cured by an effort. The prevention should begin in childhood, by the correct use of the feet early in life; but it is never too late to make such changes in the use of the feet as will improve them.

It is customary to think that the remedy for flat feet is to support the arches by plates worn under them. This is entirely erroneous. As long as plates are worn, providing they do their work at all, the foot will be comfortable and the ligaments will tighten up to some extent; but there will be little or no increase in the power of the muscles that are intended to support the foot. Sometimes plates are necessary temporarily, but they should never be adopted for permanent use in those who can be supposed to be able to develop foot power. When used temporarily, exercise is always also prescribed; and treatment planned to enable the foot to regain the strength it has lost. Very often such developmental work requires no temporary support, or at the most only a strap about the waist of the foot to hold it together and to prevent the spreading that is sometimes too great to be corrected by the muscles unaided. If in standing the foot is consciously held, as often as one can think of it, in the position already described, it will tend gradually to get the habit of correct position; but additional practice is often needed. The following exercises may be used.

Fig. 195.—Illustrating exercise 3.

1. Standing before a mirror with the feet parallel and about four inches apart, holding the ball and the heel down and the knees straight, raise the inner border of the foot as far from the ground as possible, at the same time gripping the floor with the toes.

2. Walk about on the heels with the balls of the feet off the floor, the toes curled under, and the soles facing as nearly as possible toward each other.

3. Sit with the legs stretched out, the feet about a foot apart, and try to make the soles face each other, without bending the knees.

4. Sit with one knee crossed over the other, and bend the ankle so that it brings the foot toward the knee, turn the toes upward, then bend the ankle downward as far as it will go,

then the toes downward. Carry out this succession of movements several times. Then repeat with the other foot.

5. Sit with one knee crossed over the other, and move the ankle so as to describe a circle with the toes, pointing the foot first outward, then downward, then inward and upward, exerting the strongest pull on the inward and upward motion.

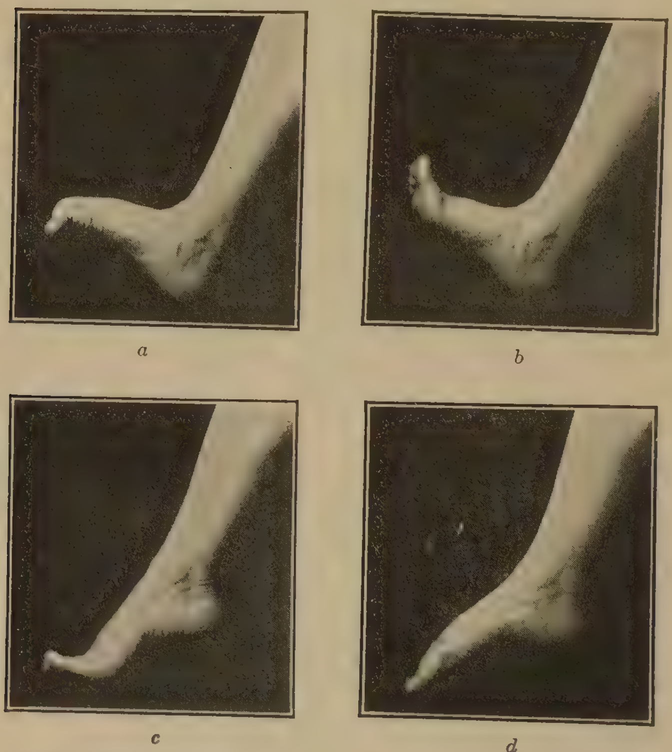


Fig. 196.—Illustrating exercise 4. *a.* foot up; *b.* toes up; *c.* foot down; *d.* toes down.

6. Practise gripping with the toes, as if trying to grasp something on the floor with them.

7. Practise moving the large toe inward, away from the other toes. It should be possible to cause it at least to lie in a straight line with the foot.

No results may be seen from these or similar exercises for some time; but, if persisted in, there will be an increase in foot

power eventually. Such exercises tend to develop the strength of both arches, by exercising the muscles that support them. They will do no good, however, unless one really uses the feet

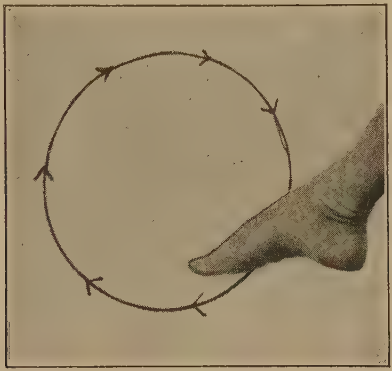


FIG. 197.—Illustrating exercise 5., foot-circling.

and toes and ankles in walking, and, moreover, uses them properly. Feet that merely dangle on the lower ends of the legs are never strong. Ankles as well as feet are not strong unless both are used. In fact most weak ankles are associated

FIG. 198.—Illustrating exercise 6.

FIG. 199.—Illustrating exercise 7.

with weak, pronated and poorly used feet. Practice in walking should include an effort to rise on the ball of the foot, to grip with the toes and to bend the ankle at each step. Most of the awkward gaits are due to failure in these respects. One

may, however, focus one's efforts on the feet alone for years without results if the body is badly balanced, so that the leg muscles cannot perform their function of holding the foot in normal position. Often the whole matter of body mechanics needs attention.

Shoes have a very close relation to the general weakness of the feet and ankles, in that they often prevent their proper use. Weak feet may be found in good shoes if the individual does not know how to use his feet; although strong feet may be found in shoes that are far from ideal if the individual does know how to use his feet. Generally speaking, it is inside poor

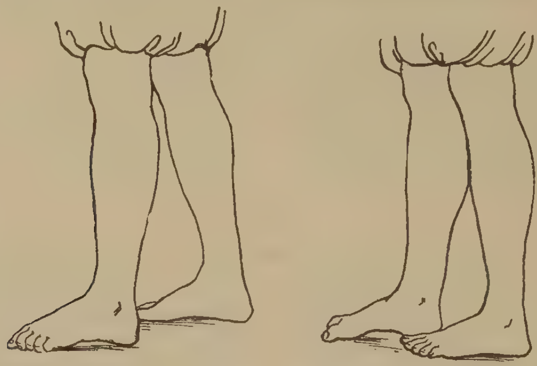


Fig. 200.—Walking with foot-gripping. (By courtesy of Women's Foundation for Health and American Medical Association.)

shoes that will most often be found weak, spreading or deformed feet, and the numerous foot defects—such as corns, calluses, contracted toes, bunions and ingrown nails. Pinched nerves and shortened heel cords, that give additional pain, are also often due to poor shoes. Feet that are misshapen, ugly and troublesome are frequently the result chiefly of abusive shoes.

There is no absolute standard for shoes, since not all feet are built alike. The requirements of good shoes are that they shall conform to the normal shape of the foot of the wearer, and shall not cramp or deform the foot, or perpetuate existing deformities. They must also permit of free motion of the feet in all respects. These standards at once place certain types of shoes beyond consideration.

The question of conformity to individual size and shape is one of fit. The most common defect in shoes is insufficient length, so that the toe-caps of the shoes press on the end and top of the large toe and cause, among other defects, ingrown nail. If at the same time the toes of the shoes are too narrow, all the toes will be cramped and a succession of bad results will follow. The large toe, when lying straight, should not come within three-quarters of an inch of the end of the shoe. Because many feet become slightly longer in standing and walking the shoes should be tried on not merely while sitting. Both shoes should be tried on, for one foot is often longer than the other. The shoe salesman is partly responsible for one's getting the correct length. The size of the shoe should be two or two and a half sizes longer than the length of the foot on his measuring stick when one is standing on it. The salesman should not be permitted to measure the foot while one is seated. The shoe that is long enough should bend where the foot bends, the widest part of the shoe being at the widest part of the foot, and the shank of the shoe fitting firmly against the shank of the foot.

Fig. 201.—Muscles of the leg, showing tendons in the foot. (Potter Compend of Anatomy.)

Fig. 202.—Foot and ankle in good position.

The width of shoes is also important, since corns on the outer toes follow the wearing of too narrow shoes, although corns may be due to too wide shoes that rub back and forth. The fit of the shoe at the heel should be close enough so that it does not slip and cause soreness. At the top of the heel it should not press against the ankle in such a way as to wear on the stocking and on the skin underneath.

The shape of the shoes is quite as important as the size. Pointed shoes on square-shaped feet always lead to trouble. If the foot is pointed, the shoe need not provide more room

Fig. 203.—Clawed toes, at times associated with short tendo Achillis and a high arch and often due to improper shoes. (From Jones & Lovett, "Orthopedic Surgery. Courtesy of William Wood & Company, Publishers.)

than is necessary for all the toes to lie out flat. Ordinarily a pointed shoe crowds the toes together, even perhaps raising one toe above the others. It also causes pressure over the joints of the toes and may make a row of corns indicating where the pressure occurs. The only way in which an individual whose feet are somewhat square can wear pointed shoes is to have them so long that the point does not limit toe room.

A more serious result than corns comes from the wearing of too pointed shoes, in that they prevent the toes from working, and assisting in weight-bearing. Under such circumstances, the ball of the foot has to bear the whole weight and the

anterior arch flattens and calluses form. It should be possible for all the toes to lie flat at the beginning of each step and to bend at the end of each step.

FIG. 204.—X-ray showing hallux valgus, bunions. (From Sever, "Orthopedic Surgery for Nurses." By permission of the Macmillan Company, Publishers.)

One of the chief difficulties in pointed shoes is that the point tends to push the large toe toward the mid-line of the foot.

Cramping of the other toes is not half so important as cramping of the large toe. If this is done, there is a considerable amount of pressure and strain on the joint of the large toe, and swelling, pain and perhaps a bunion will follow. The prevention of bunion is by not crowding the large toe out of its normal straight position. After irritation of the joint of the large toe has begun, it may sometimes be stopped by changing the shape of the shoes to one with a straight inner line, and by devices to hold the toe straight, such as a wedge between it and the next toe.

There is much loss of mechanical power in the foot if the large toe turns away from the inner side of the foot. Decreased marching ability in the army was shown to be often in direct

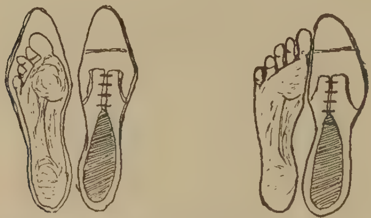


Fig. 205.—The effect of pointed shoes and of shoes with a straight inner margin on the shape of the foot.

Fig. 206.—The foot of a child in a shoe of natural shape.

proportion to the degree of deviation of the large toe. As a problem in physics, it has been demonstrated that the body is harder to balance without the assistance of the large toe. Furthermore, unnatural strain is placed on the muscles of the legs and even of the back if the body must be propelled without the propulsive power of this toe at each step. A shoe should not be considered of satisfactory shape, no matter how wide its toe, if its inner line is not straight.

Aside from the shape of the shoe itself, the shape of the heel is of importance. Man is said to be a plantigrade animal as distinguished from such animals as the horse which are digitigrade, walking on the toes. Actually, because of the heels on shoes, man is only semi-plantigrade, and if very high heels are worn approaches the horse in the method of use of the foot. But whereas the foot of the horse is adapted to such use,

that of man is not. By raising one end of the longitudinal arch, this arch tends to become flattened. At the same time, the anterior arch tends to be flattened, because of the unusual amount of weight and strain placed on the ball of the foot. Furthermore, high heels tend to throw the body out of alignment—a compensatory bending of the knees, hips, and spine often occurring. The result of high heels includes the effects of too great strain in the parts of body that are out of line.

Fig. 207.—*A*, foot of a Bagobo boy who had worn shoes only a few months contrasted with *B*, foot of an adult Bagobo who had never worn shoes. (P. Hoffmann.) (From Jones and Lovett, "Orthopedic Surgery." Courtesy of William Wood & Company, Publishers.)

It is very difficult, for example, in high-heeled shoes to get the back flat or to keep it flat in walking. High heels also tend to give less stable posture and more frequent accidents. One-half of the accidents in one group of industrial women were due to tripping or slipping, practically all of the women having had weak feet and ankles and most of them wearing high heels.

The heels of shoes for daily use should not be much more than one and one-quarter inches high, and they should be nearly as broad at the base as at the top. If high heels are worn occasionally by the individual who has strong, well-used feet, no particular harm will result. In dancing, the use

of high heels does not do much harm, providing the shoes are long enough, in view of the fact that the weight is in any case on the ball of the foot. The individual whose feet are weak and whose posture is poor should not wear high heels at all until these conditions are improved. Usually high heels will be found, not on those who might be safe in wearing them, but on those whose feet are weak, the type of heels they have worn having had a great deal to do with producing the weakness.

There are those who are uncomfortable in low heels because of various existing foot deformitities, one of which may be contraction of the cord extending upward at the back of the heel (the tendon of Achilles) so that the foot may not even be brought to a right angle with the leg. Entirely heel-less shoes (moccasins, sneakers and gymnasium shoes) should be perfectly comfortable for a normal, strong foot. If they are worn even for a short time by those with weak feet, they are likely to be uncomfortable; but the discomfort is not a disadvantage if it suggests the necessity for strengthening the feet and leads to efforts to do so. If worn for so long a time as to cause acute discomfort, they may do some harm. The feet should be rested, and thereafter heel-less shoes be used only for short periods, until the foot gradually gets used to them. The same applies to any new shoe that is better than the ones usually worn, but to which the weak foot is not yet accustomed. They should be worn only for a short time, and foot exercises should be done every day.

There are shoes that are called "corrective" in that they are intended to correct foot weakness and deformities. They are only able to remove sources of further injury to the feet and to permit correct motion. It remains to the individual to use the motion they permit. Much disappointment arises from adopting orthopedic shoes, if they are mistakenly relied upon to do what the individual must do for himself, and what they merely make easier for him to do—namely, to use the feet properly. The shoe's function is passive; that of the individual, active.

Shoes that are of a natural shape are often called "freak" shoes. The name is only justified by the fact that, in adults,

feet of a natural shape are so rare. Actually the sort of shoes usually worn are freak shoes for freak feet that bear only very slight resemblance to the sort of feet with which one was born. That one can get used to them is a tribute to the adaptive power of the foot, which is, however, very often taxed too far. At the first sign of trouble a shoe that more nearly approaches the shape of the foot should be worn. Such a shoe should, of course, always be worn when the feet are to be much used, except possibly in dancing, when some concessions may be made because of the way in which the feet are used.

Freedom of foot motion has been made more possible by the universal use of low shoes. This gain is sometimes sacrificed if the shoes are not fastened about the waist of the foot in any way, but rely on their tightness to hold them on, as may be the case with pumps.

A certain degree of flexibility of the shank of the shoe makes for better foot motion. Whether it be entirely flexible or not depends on the use to which the shoe is to be put. For most forms of athletics it is better to wear shoes with as yielding shanks as possible—perhaps a flexible rubber sole. For ordinary purposes an ordinary shank is satisfactory, provided it permits the shoe to bend where the foot does. A metal shank is in the same class as the arch-supporting plate.

The sole of the shoe should be flat rather than of the "rocker" type, curved up at the toe. A thick sole of this shape may do much harm by preventing use of the toes. If soles that were originally flat tend to roll up at the toes, poor use of the toes should be suspected. Shoe trees should be used in the shoes at night to prevent their loss of shape in this and other respects, although well-fitted shoes, worn on normal, well-used feet, show little tendency to lose their original contour.

Heels of rubber add to the springiness of the gait, but it should not be necessary to wear them for the reason that one comes down so heavily on the heels that the whole body would be jarred without them. They are often worn because they are thought to wear off less readily than leather. It should be realized that wearing off of the heel of the shoe on the outer

side is due either to the fact that the shoe does not fit (is too short, or slips at the heel, etc.) or that the feet are not used properly (the toes not used, the foot turned out, the foot pronated, etc.). Unfortunately the method usually adopted to correct this habit is exactly the one to make it worse. Individuals usually try to roll the foot inward so that the weight comes on the inner side. In so doing they make the use of the feet still worse, and the wearing off of the heels incidentally still worse.

The necessity for "breaking in" a pair of new shoes means that the shoes do not fit and must be pressed on by the foot to make them do so. The result desired is not usually attained; or, if so, the necessary pressure on the shoes is felt also by the feet. It should be possible to be as comfortable in new shoes, if they are well chosen, as in old ones. If a poor choice is made, it is bad economy to continue trying to "break them in."

Since the feet are relatively very small structures for the strain they must carry in weight-bearing, it is distinctly worth while to give some attention, or indeed considerable attention, to acquiring the knack of using them properly, in order to preserve their present strength or to develop strength where weakness exists.

CHAPTER XXVII

EXERCISE AND ATHLETICS

Exercise is the use of the muscles with particular physiological ends in view, these ends involving the muscles themselves and the whole body. Many forms of work and play involve much use of the muscles and produce the same physiological results as does exercise deliberately taken to produce such results. Without any concept of the need of exercise, many individuals unconsciously satisfy the instinctive urge toward motion, and respond to the unrecognized bodily-felt needs for what motion does; for it is instinctive to wish to move. Perhaps the most typical thing about a living organism, that distinguishes it from everything non-living, is that it can move and change its position in relation to its environment. Life and motion are almost synonymous terms.

Animals, infants and children need no instruction about the benefits of exercise, and no gymnasium in which to carry it on. Normal adults, who have been brought up in natural ways, have similar impulses to activity. It is hard to keep a child quiet even for a short time. A normal adult, brought up without restraint of activity, often finds immobility difficult to maintain completely. Even the most sluggish person may make numerous small motions, such as tapping with the foot or drumming with the fingers, which are, however, poor substitutes for the large motions the body really craves.

Having attained the ability to remain relatively quiet, however, many individuals thereafter find exercise repellent. Usually it is because voluntary and habitual restriction of exercise leads to weak muscles that easily feel fatigue. A sort of vicious circle is thus established; sitting still leads to weak muscles and weak muscles lead to sitting still. Particularly is this true if the muscle that is the heart is allowed to become weak. As has been mentioned, weakness of the muscles

controlling foot action has a good deal to do with disinclination to exercise.

Exercise is unpleasant to many of the student type, who maintain that exercise interferes with study, because of the time it takes, the interruption to long periods of concentrated brain work, the fatigue and especially the sleepiness it induces—all of which is actually hampering to brain work, they think. Although granting, perhaps, that exercise may give health, they maintain that it causes weariness of the soul, which more than balances any physical good it might do. They even doubt whether it does give health of body. At all events, they consider the degree of health they possess proportionate to their very moderate needs of a physical sort, and believe that exercise would be a tax on them rather than an advantage to their health—such exercise taking strength needed for mental work, as well as wasting time, and being generally superfluous.

Arguments against exercise are, however, found to be arguments against unsuitable exercise. Individuals are not alike in the demands their bodies make for exercise, nor in the effect of a given amount or kind of exercise on them. That is the reason for physical examinations before the prescribing of exercise. Only that sort and kind of exercise is chosen for each individual that will not be a waste of time, nor a source of additional fatigue of undesirable degree, nor interfere with brain work, nor be too boring. Physical education has been introduced into colleges and schools not in order to sacrifice study to physical development, but to make both study and life generally more agreeable and successful because of the possession of sufficient physical health, as gained partly by physical exercise.

The immediate effects of inactivity are appreciable to the individual who is accustomed to exercise and misses it for a few days. But these effects are not observed by the individual who never takes enough exercise, or who does not take the right sort of exercise to get the good effects. Whether the immediate effects of lack of exercise are important or not, the remote effects of the sedentary life, however, are very great. The degenerative diseases of middle life, that are due largely

to a defective circulatory system and retention of toxins, are made much more likely for the individual who acquires habits of inactivity. Even if such diseases are avoided, the individual is often just below par for no other reason except that lack of exercise has interfered with his heart and respiration, his circulation and oxygenation, his temperature regulation, digestion, elimination, sleep and rest. In addition, his nervous control, and even his brain work, for which he has perhaps sacrificed health, are unlikely to be as good as if he had not made the sacrifice. The sedentary individual usually develops poor posture and its attendant bad results; often gets stiff in the joints; generally puts on weight; has lowered resistance to all sorts of diseases, because of tissue deterioration; and, in short, reaches an early old age.

It ought to be thought of as quite as important to get medical advice about the limitation of exercise as about increasing exercise, for the effects of doing nothing are as likely to be injurious as the effects of doing too much. Before feeling privileged to do no exercise, one should understand what the results are likely to be in one's own case. For certain types, lack of exercise is distinctly hazardous. Physical discomfort and mental sluggishness are often the price mistakenly paid for an unwillingness to respond to what should be an instinctive urge if it were not blindly thwarted.

The effect of exercise is primarily on the muscular system, but through its effect on the muscles all parts of the body are affected. Attention is focused on the muscles, however, since it is known that if they are suitably exercised, the beneficial effects on the rest of the body will inevitably follow.

The muscles were developed to their present size at a time when muscles were necessary for self-defense and self-preservation. Having them still, it is necessary to use them in order to keep both them and the body in health, although they have not the great use for the majority of individuals that they formerly had. Even so, they are of importance in three ways that justify our still having them and developing them. First, the skeleton cannot be kept in alignment without them; second, the organs cannot be kept in proper position unless the skeleton and the musles coöperate for that purpose;

third, the activity of the circulation throughout the body, to each cell, depends to a considerable degree on the pressure exerted on veins and lymphatics by contracting muscles.

In assuming the upright posture, the need of the muscles became more important in these respects than they had been before. Now, although for many little muscular effort is needed to make a living, life cannot be very satisfactory unless the muscles are definitely used for these three particular purposes.

In order to have them in satisfactory condition to maintain posture, it is necessary that they be in much better condition than would be necessary for the other uses in motion and locomotion, which have become so limited in many individuals. Without a minimum of voluntary effort, the opposing sets of muscles will reflexly keep the body only very inadequately balanced. The result will be the drooping posture and sagging organs associated with so much ill health. Were there no other reason for the cultivation of muscle power, this alone would be sufficient reason for it.

But at least a minimum of muscle power is necessary to give even those of sedentary habits an ordinary degree of skill in the use of the body in their occasional active occupations, such as walking and dancing. These simple uses of the body are likely to be awkward if the muscles are weak. But they are also likely to be awkward, whether the muscles are weak or strong, if no skill has been developed in the use of the muscles. This is another aspect of muscle training that is quite as important as the development of their strength.

Awkwardness may be the accompaniment of great strength which lacks training in coördination. Strength and skill are not synonymous. Other things being equal—that is, with the same amount of training—one expects the individual with stronger muscles to be able to develop better technique in bodily motions. The awkward individual with weak muscles and loose joints needs both muscle development and training in coördination before he can even walk in good form. The awkward, muscular individual needs muscle training in the smooth coördination of one muscle group with another. It is certain that lack of grace is responsible for a large number

of accidents that are quite avoidable by those who have both power in muscles and the technique of using them. This practical aspect of awkwardness is fully as important as its aesthetic aspect.

Next, muscle power should be developed so that easy fatigue may be avoided. Without it, even the sedentary individual who makes few demands on his muscles, finds that the mere effort of balancing in sitting, and his slight incidental use of the muscles, cause great fatigue. If it is necessary to do anything unusual, the fatigue may be so great as to prevent his being able to undertake what he ought and wants to do, or so great as to incapacitate him for a day or more after it. In other words, the man becomes a slave to his weak musculature, rather than one who can utilize his body for his own ends.

Finally, muscle development should be sufficient to permit of meeting any of the ordinary emergencies such as are likely to arise in any life. It may be necessary to walk farther than one is accustomed to do, or to run to avoid danger, or to lift a heavy object, or to climb a fence. While taking enough exercise to keep the muscles in health, and to develop ordinary skill in their use, the musculature will be kept in a condition that will enable one to meet adventure half way.

It is easy to neglect the voluntary muscles because they perform our small needs fairly well, and because symptoms due to their neglect are more often felt in other organs than in them—although this is usually not apparent. It is easier and more natural to blame the organs showing the symptoms than to trace the trouble to its frequent source in the muscle system's neglect.

Exercise of the muscles should be directed toward keeping them well nourished. This is not the same as causing them to increase in size. They may increase in health and in power without much increase in size, especially in women. When this happens, the improvement is due to their improved tone and to the improved coördination of them in use. Quality is always more important than size. Good quality involves cellular superiority and chemical superiority. The cells are more active, contain fewer metabolic poisons, and, what is

more important, each cell in a muscle, instead of a few, is used when the quality of a muscle is good.

One does not want large muscles unless the occupation calls for great muscle power. But one does want useful ones, that will work without fatigue at the tasks at which one wishes them to work, and that will be a help rather than a hindrance to body health generally.

Some individuals naturally have poor development of muscles, and find it hard to get even fair use of them. Some-

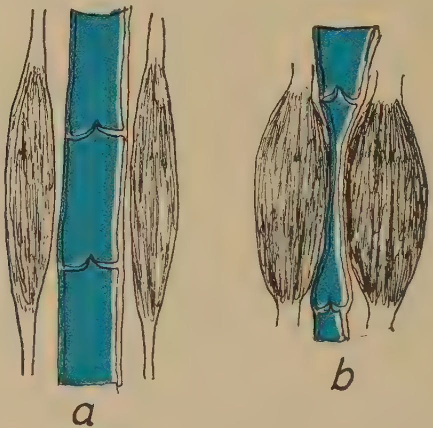


Fig. 208.—Diagram of vein between two muscles (a), showing the effect on the vein of muscle contraction (b).

times this is due to poor early nutrition, sometimes to present malnutrition, sometimes to endocrine gland difficulties. Most often it is due to lack of consistent use.

Exercise helps some individuals to get larger muscles; it helps most to get stronger muscles; it helps all to get better circulation, even though the muscles themselves are not apparently changed. Furthermore, it helps the tendons, the ligaments, the joints and the bones involved in the exercise, through the improvement of their nutrition.

The heart is usually not thought of as a part of the muscular system, although it is perhaps the most important muscle to keep in training. Its training comes about, however, only

through the use of the musculature as a whole. If the whole musculature is flabby, the heart is most likely to be flabby also, and to carry on circulation poorly. This relationship between the heart and the skeletal muscles is almost invariable. In certain disease conditions of the heart, it may develop to an abnormally (pathologically) large size while the general musculature is poor. Usually its power is in proportion to the power of the skeletal muscles.

The heart is capable of improved efficiency by means of wisely chosen general exercise. The kind to be chosen depends on the observation of the effect of exercise on the rate and regularity of the pulse, and on the level of the blood pressure, and on the changes in both that take place during and after exercise. In excessive exercise the changes produced are also excessive or abnormal, and the return of the heart after the exercise to its normal state is not prompt. Exercise is sometimes to be limited on account of the condition of the heart, pending a gradual increase in its power by gradual increase of exercise. During illness, especially that due to infection, the heart muscle is unable to stand as much exercise as usual. Exercise is therefore much limited during illness and fever.

Only a few individuals, even with defective hearts, cannot take any exercise at all. In any form of illness, the possible strain of the weakest organ, whether it be the heart or the lungs or the kidney or any other organ, is taken into consideration in prescribing exercise. But there is some form of exercise that is suitable for almost any individual who is able to be about.

The beneficial effect of exercise on the general health is proportionate to the beneficial effect on the muscles themselves, especially on the heart. Exercise, in producing health of the muscles and of the heart, causes certain physiological changes to take place—notably, changes in circulation, respiration and blood characteristics in particular. It is by means of these beneficial changes that the whole body is aided in its functioning.

A prominent writer on hygiene lists twenty-seven good physical effects of exercise. A student who understands the physiology of the circulation and of the respiration and the

effect of both on all body functions, should be able to make a list almost as long.

The experimental study of animals and man shows that the life and activity of cells depend on their supply of blood, carrying oxygen and food and removing waste. When the muscles are exercised, they have markedly increased needs for oxygen and food and for elimination of waste. In providing for the needs of the widely distributed muscles, circulation is activated. Exercise thus provides incidentally for the needs of all other cells, and increases their functional power. In order to supply the muscles with oxygen, the blood must develop more red cells and more hemoglobin. In order to supply the muscles with food, appetite increases, digestion improves and assimilation of food is better. In order to get rid of muscle waste, elimination from the kidney and the lungs and the alimentary tract is more perfect. In order to give the muscles enough blood, internal parts of the body are relieved of an excess of blood that would otherwise amount to harmful congestion. In order to supply the muscles sufficiently rapidly with blood, the vasomotor system must be lively in its responses, and this insures quick adaptations to other needs of redistribution of the blood, as, for example, in temperature regulation. In supplying the skeletal muscles with necessary stimuli, the whole nervous system is increased in tone and power.

The effect on the alimentary tract is quite marked in several ways. First, the secretions are increased, so that digestion is better. The individual can usually deal adequately with more food. Second, exercise produces an agitation of the alimentary canal that favors its action. Third, the breathing is deeper, the abdominal organs are pressed upon by the diaphragm and their action is improved as their circulation is accelerated. Fourth, the same deep breathing during exercise increases the lymph flow and the venous flow through the abdominal organs, and this rids the cells of waste more rapidly. Fifth, intestinal elimination is improved both because of the massage effect of the muscles as they move and press upon the intestine, and because of the shaking up that is given the intestinal tract in exercise. Sixth, the more active nervous

system stimulates more fully the peristaltic action of the intestines.

The well-exercised individual usually is not prone to fainting, because of the better acting vasomotor system; is not prone to colds, because of the better temperature regulation and the better health of the individual cells of the respiratory tract; is less susceptible, in fact, to disease of any organ or part of the body.

The relationship between exercise and weight is quite close. A suitable, usually very moderate, amount of exercise tends to improve the nutrition of those who are thin, and a suitable, usually quite large, amount of exercise tends to decrease the fat deposits on those that are over-weight. In other words, if carefully chosen it tends to normalize the body weight. In some cases, it increases weight but not girth. In replacing fat by well-developed muscles, one is replacing a bulky but light tissue with a more compact but heavier tissue. The measurements may therefore decrease, even though body weight does not. Any efforts to influence weight, in either the thin or the fat, should be under medical supervision, however.

The general improvement in the skin under exerise is due partly to the increased amount of blood supplied to the cells of the skin, so that their resistance to infection is better; and partly to the improved elimination of waste from the intestinal tract.

The effect of exercise on the nerves and the brain is due partly to the training of the sensory and motor nerves, along with the muscles, and partly to the increased circulation to these vital parts of the physical and mental life. The brain seems to function better, within its original limits, as a result of the increased neuromuscular coördinations and the increased circulation induced by exercise. There is often observed in the same individual a variation in respect to alertness, quickness of decision and initiative, apparently attributable partly to the variation in the amount of daily exercise. It is certain that "fidgets," irritability and moods are more frequently found in the unexercised. Perhaps part of the better poise of those who exercise is due to the sounder sleep exercise usually gives.

The amount of exercise needed to give health varies with the individual. Athletes are usually well, but it is not necessary for all to become athletes in order to be well. If one chooses a sedentary life by preference, whether it involves brain work or not, a minimum of exercise must be taken every day.

One may not count on exercise to counteract the effect of breaking other health laws, or to get one back into condition after having broken them. A great deal of exercise at a time when one is out of condition does not restore health, but may be actually dangerous. The man of adult years who suddenly realizes that he does not feel well, and belatedly recalls the benefits of exercise, should curb his new enthusiasm and begin his exercise gradually.

The regularity of exercise is its chief advantage. Severe spasmodic exercise is often injurious. After having injured the body by lack of exercise, it is not fitting to injure it still more by an excess.

The question of the amount of exercise that is worth while in a busy life is an important one. Beyond a certain degree, exercise is not a necessity but a luxury. In taking exercise, it should be clear whether the price in time and effort is being expended for that which is actually a necessity or for that which is merely agreeable. Certainly it should be determined that the amount taken is not actually harmful.

The statement is often made by individuals who are doing no formal exercise that they are getting enough at their work. This may be true. But there are very few occupations, even those that entail considerable muscular work, that involve all the muscles of the body. Those muscles that are most likely to be neglected are some of the most important ones. Even the individual who walks a good deal does not get all the exercise demanded by the trunk muscles, and uses the diaphragm less than in some other forms of exercise.

The general aim should be to take such exercise as will make the heart beat faster and harder and the breathing to be definitely deepened at least once a day. The routine for the sedentary worker should include at least two miles of brisk walking, setting-up exercise in the morning for at least five minutes and the usual "tub and rub." Once a week at least

there should be some form of sport involving the extensive use of the muscles, preferably an outdoor sport. The adult of middle age, already immersed in many affairs, can hardly get along well on less than this. He will probably get along much better on a good deal more.

During the early adult years, while the status of the health is being established, more vigorous exercise is to be desired. Wherever a well-conducted gymnasium is available, it should be utilized several times a week, at least in the winter. The exercises should include those to activate the circulation, those to give correct form in ordinary motions of everyday life, those to develop special body skills, and those to strengthen muscles that are particularly essential to the maintenance of posture. In addition, special exercises may be used to strengthen any part of the body that is weak, or to improve the function of a part of the body that is functioning poorly. For the latter purpose, there are special exercises devised for improving the tone of the muscles that support posture and the feet; those that help relieve congestion and malposition of organs, thus tending to relieve such conditions as constipation or menstrual pain; those that increase the tendency to use the lower chest in breathing; and those that are graduated carefully in order to increase the power of the heart.

Deep breathing exercises have been alternately lauded and condemned. They have been falsely lauded as a means of getting more oxygen into the system. They do not do this, since one cannot take into the cells of the body more oxygen than the cells demand. In order to get more oxygen into the body it is necessary to make the demand for it greater, and this is accomplished by any active general exercise. The benefit of breathing exercises is, however, very great, if they are used for the purpose of developing the muscles that control respiration, and making the joints in the chest more movable, so that the lungs may and will be properly expanded in ordinary breathing.

Insurance companies believe that an expansion of the chest in respiration to the amount of two inches is important as an indication of health. Most observers would agree that the individual with the cramped, narrow, relatively immovable

chest is not likely to be as good a risk as the one who breathes freely. Many physiologists believe that there is a direct ratio between lung capacity, or vital capacity, as it is called, and general health.

It is the circulation, however, that profits most by adequate breathing—not the lungs. When the chest widens at each respiration, and the diaphragm moves up and down freely, the heart is given more room to work in, and there is a definite suction action of the diaphragm on the blood and lymph vessels entering the chest, activating the flow of both venous blood and lymph. Breathing exercises, that train the muscles of respiration to carry on correct breathing habitually, cannot help having value, although from the point of view of increasing the intake of oxygen their value is negligible.

The best way to get one's general exercise is to combine it with one's pleasure, as in sports. It is unfortunate that this may not be done by a larger proportion of the population. As it is, sports are the privilege and the luxury of only a relatively small number of those who would enjoy them. The choice of sport has to be made by many on the basis of what is available. If one has free choice, sports should be chosen on the basis not only of fancy but of physique. But any sport an individual really enjoys is better than no sport.

Sports should be begun in youth, for at that time it will be possible to acquire some skill that will increase as time goes on. One tends to have greater enjoyment in doing that which one can do well. Golf or tennis or skating taken up in one's later years are often robbed of their joys in the humiliation of inexpertness. Moreover, if one enjoys a sport, there is more reason to think it will be continued into the years when exercise habits are most likely to be dropped.

If it is possible, some of the sports that are chosen should be the outdoor ones, and those that can conveniently be continued through life. It is better to have an interest in several sports rather than in one only. At least one of these should be of the sort that is done in groups; and at least one, of the sort that may be done by one's self.

Sports involving competition are usually particularly interesting, although self-competition, as in golf, may be almost

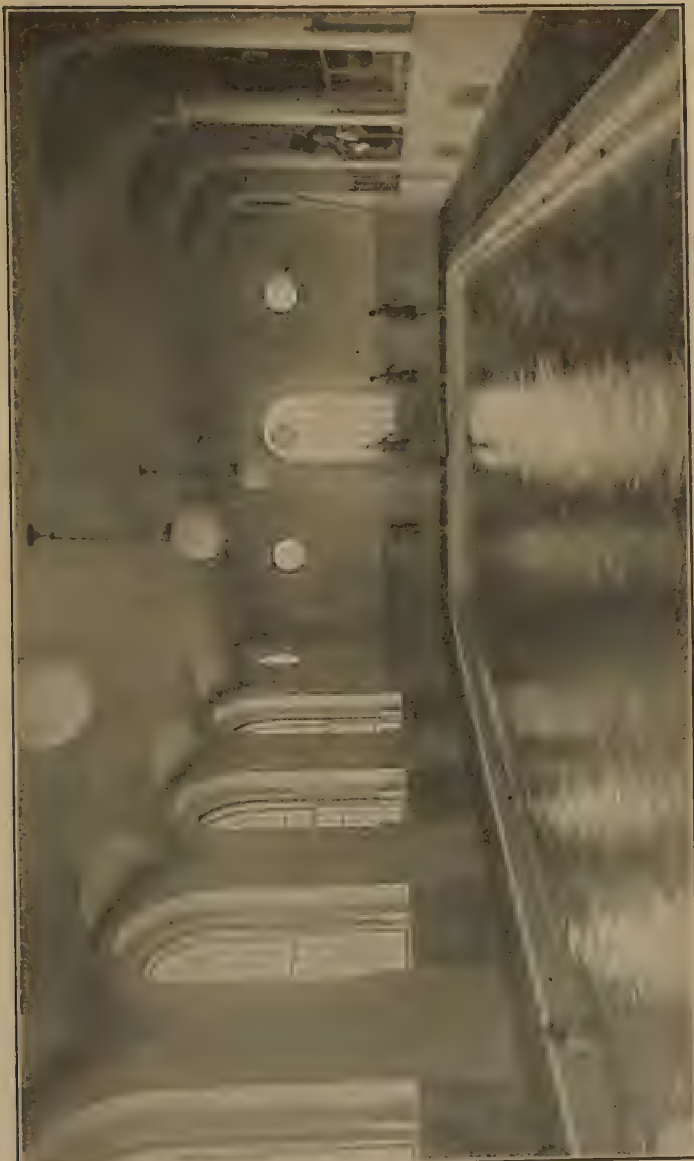


FIG. 209.—Smith College swimming pool. (Stahlberg.)

as interesting. Physical examinations should always be done before teams are made up, in order that the members may be quite equally matched. It is too easy for the strong ones and too hard for the weaker ones, if a team is composed of individuals of unequal standing. It is fairer to one's team-mates not to engage in competition in which the dropping out of one member, because of lack of endurance, would endanger the game; and it is fairer to one's self not to enter competitions from which one does not feel free to drop out when too fatigued to continue.

Endurance tests, both for time and distance and amount of work done are injurious to certain types of individuals. It should therefore be ascertained by each individual, before engaging in them, that they will not be hazardous for him. Training is an important part of the preparation for all competition and for all feats of endurance. By beginning gradually and working up to a high level, much more may be safely accomplished. The training rules about living are as important as the gradual training in exercise itself.

An individual who is doing more strenuous exercise than he should, shows it in ways that are observable by those who are not physicians. The individual himself will notice undue breathlessness; a "stitch" in the side, perhaps; rapid beating of the heart; or a feeling of constriction in the chest. He may feel faint or perhaps nauseated, or dizzy, with perhaps a throbbing in the head. To the observer he will be seen to be breathing rapidly and in a shallow way, with the mouth open, the nostrils contracted, the neck muscles tense, the veins distended. The skin will be either pale or a dusky bluish red. If such symptoms are disregarded and the individual persists in the exercise that produces them, the symptoms tend to come on earlier each time. Decreased power results. If, however, one stops short of such symptoms, there will be a gradually increasing ability to work without danger. There is no virtue in using every ounce of one's strength.

Stopping one's exercise habits suddenly is almost as bad as beginning them too suddenly. One should train down as well as up. Or better still, do such exercise as may be continued. The often-referred-to "athlete's heart" is one that has been

accustomed to much exercise and has later ceased to get it. By diminishing exercise gradually and by diminishing the amount of food, so that less is eaten than an athlete usually eats, there is less danger of bad effects following the cessation of an athletic career.

Sports are chosen as the best form of recreation by many individuals, because they like them and because they find them an antidote, both physically and mentally, for the possible bad effects of too much work.

Sports come, thus, under the heading of recreation, which may be defined as activity taken for pleasure. As the term implies, it presumably has the effect of re-creation, whether taken for that purpose or not.

The choice of recreation should be primarily for the pleasure it affords, but from among those forms that are in accord with, rather than opposed to health aims. It should not, as a rule, be of a nature similar to one's work—that is, it should not all be sedentary recreation if one's work is entirely sedentary. Recreation should be as carefully chosen as one's work itself. The test of its value should be the pleasure it gives and the effect it has on the advancement of one's major aims.

There are those whose work is so agreeable that they feel no particular need of any other pleasurable activity. Experience has quite generally shown, however, that pleasant though one's work may be, it is not all that is needed. Those who do not take recreation often argue that it takes time from their valuable work and that they are happy without any diversion. Those who do take recreation find that if it is carefully chosen, it improves the quality of their work, and that it also improves both physical and mental health.

CHAPTER XXVIII

FATIGUE

It is neither possible nor desirable to try to prevent all fatigue, for fatigue is both normal and necessary within limits.

Fatigue is the natural result of activity. The body works, glycogen is consumed, fatigue products appear, the sensory nerve endings are stimulated by them, giving the well-known sensations that defy description by any other term than that of fatigue or tiredness.

The fatigue products are the result of katabolism, largely the result of muscle activity. They consist mainly of carbonic acid gas and sarcolactic acid, the result of cell activity. While they are present in a muscle, the muscle is so clogged with them, especially with lactic acid, that its power to carry on further work is lessened.

Fatigue may be produced locally and may remain so if the fatigue products are gotten rid of by rest before the whole body is flooded with them. But general fatigue often results because of the continuation of activity to a point where the locally produced toxins circulate through the whole body. The toxins may even be produced in the muscle tissue all through the body.

In either case one usually stops activity at such a time as the toxins have been produced in such an amount as to cause one to feel either locally or generally fairly uncomfortable. Fatigue may therefore be defined as a physiological state produced by activity that limits the quantity and usually the quality of further work, and that usually takes away the desire for further work.

The cessation of activity is usually voluntary at the point of considerable discomfort. It usually does not come as the result of absolute necessity because of either the total consumption of glycogen or of the absolute hindering of

activity by accumulated metabolic products. Work is usually stopped long before it actually could not be carried on any longer.

The products of activity that cause fatigue are recoverable from the blood of a fatigued animal. If a dog is exercised to the point of excessive fatigue, his blood may be injected into a dog that has been resting, producing in the rested dog every evidence of great fatigue and a lack of desire for activity.

Examination of the body cells of an animal that is excessively fatigued shows that changes that are visible under the microscope take place in its cells. Their appearance is not like that of resting cells. One would expect that after muscle fatigue the muscles would show chemical changes as they do. But it is furthermore true that the nerve cells that supply the acting muscles also show changes. In fact the physical changes in them are more prominent than in the muscles. In experiments it may be shown that in great fatigue the muscle may still be stimulated to contract after a point has been reached when the nerve to the muscle can no longer be stimulated. In fact, however fatigue is produced, there is thought to be some cell deterioration throughout the body.

Deterioration in the nerve cells may be produced by their own activity, or may be produced by transfer of toxins from other fatigued parts. Changes in nerve cells have, for example, been observed in carrier pigeons after a long flight. In many occupations, fatigue of the nerves is due to both causes—actual work of them and transfer to them from other working parts. Under the microscope it is observed that the cell body has become smaller and that the nucleus does not appear as solid as when rested. Minute structures in them—called Nissl bodies—that may be the source of nerve cell activity, tend to disappear.

The nerve cells, however, have great recuperative powers, as have also the muscle cells, so that a normal amount of fatigue need not be feared. It is only that degree of fatigue that is excessive and prolonged and cumulative that leads to permanent damage. It is not necessary to adapt one's self to a life of perpetual ease in order to avoid fatigue.

Although the products of fatigue are spoken of as toxins, they are in ordinary amounts not actually poisonous, but only potentially so.

The feeling of fatigue is plainly a protective mechanism, whereby the body is led to get the rest that its cells need, in order to avoid too great production of fatigue substances and in order to get rid of those that have already formed. The blood as it circulates through the body receives from the fatigued parts the waste products that have accumulated, while furnishing a new supply of fresh blood, freshened because it has already carried some of the toxins to the excretory organs for excretion. In a varying length of time all products of fatigue are either reconstructed into glycogen or are excreted, and the cells have regained their usual state. The sensory nerves are no longer so stimulated as to have the sensation of fatigue. A renewed desire for activity appears.

The cycle of activity and rest should be continuous through life. The cells do better for being regularly worked and regularly fatigued, and as regularly rested and restored. It is only by work, with the accompanying increased circulation, that the power of any cells is increased. No progress, either mentally or physically, is possible without some effort and some fatigue. Normal fatigue is an indication of having worked enough to gain additional power in the parts used, and enough to set an adequately lively pace for the circulation.

There is, however, a degree of fatigue that goes beyond the physiological limit. Such fatigue is either acute, such as follows unusually severe activity, or activity at high speed or of long duration; or chronic, the result of the continued piling up of toxins, those of previous fatigue not being removed before more are formed.

The harmful conditions produced are not only felt by the parts used, but by the whole body, especially perhaps by the nervous system. Permanent ill health may result. The effects are especially apparent in one's weak spots. If there are no particularly weak spots, body function as a whole may be less good, digestion is likely to be impaired, sleep less refreshing, and resistance to infection less. The phagocytic cells and the protective substances in the blood serum are thought to be

made less effective because of the perpetually acid medium in which they have to work.

It is of course important to determine whether a given state of fatigue is normal, "healthy," physiological fatigue, beneficial to the body; or pathological and harmful. The amount of activity which causes in one individual only an increase in health, will perhaps in another individual cause an excess of fatigue. The result depends upon the physique and the health status of the individual.

Susceptibility to overfatigue is noted in those who inherit or who have acquired a poor constitution. The threshold of fatigue is also lowered in those whose nervous systems are below par and in those who are malnourished. It is also lowered during illness and convalescence, and in states in which functional or organic disease of one part of the body affects the healthful functioning of the whole. Those whose musculature is poorly developed, those whose hearts are flabby so that circulation is inadequate, and those whose red blood cells are too few or deficient in hemoglobin, are particularly likely to feel fatigue too soon and too intensely.

The symptoms of fatigue are many of them subjective, that is, apparent to the individual himself, but not measurable or even, sometimes, observable by others. They include primarily a wish to stop activity and to rest, in fact an imperative inner demand to do so. Along with this feeling, there are the bodily sensations of vague discomfort, perhaps actual pain; and the sensations in the head that are called mental fatigue, sometimes described as a dull, heavy feeling. One may be aware that ideas come slowly, that it is difficult to concentrate, that distractions gain increased power to disturb, that irrelevant thoughts enter the mind unbidden, that thinking is inaccurate, and that somnolence, or its opposite, restlessness, is hard to control.

Prominent symptoms of fatigue in the case of most individuals are emotional changes. One is likely to become "touchy," "snappish," irritable, worried, anxious, bored, or tearful, as the case may be.

Objective signs of fatigue are largely those due to disturbance in the motor field—incoördination of muscle and nerves,

weakness of muscles, or twitching of them, awkwardness, lagging steps and slumped posture. The countenance and the disposition frequently cause fatigue to be observable to others.

In connection with fatigue produced by industrial work, efforts have been made to determine objectively at what point a worker passed the stage of normal fatigue and was being overworked. There have been no valid tests devised as yet, however. It is impossible to examine cells in a living body to see whether they are fatigued. It is even at present clinically impossible to conduct satisfactory examinations of the blood for the purpose of determining the degree of fatigue. About all that can be done in industrial investigations of the amount of fatigue is to measure the amount and quality of work done. That there is some relationship between the two is quite apparent. But it is also certain that both may fall off for other reasons than fatigue—for example, boredom. Experiments with workers at the beginning and the middle and the end of the day show that working power increases for a time, holds steadily for a longer time and then begins to fall off. Industrial managers have usually concluded that working hours are not profitably to be continued after production falls off. On the other hand, there is no absolute correlation between the subjective feeling of fatigue and productive power. When feeling the least fatigued one may be producing the most, and vice versa. Usually genuine fatigue gives a lessened production of any kind of work, even of mental work, and a larger proportion of poor work, whether it be rubber shoes or problems in trigonometry.

It is desirable for an individual to study his productivity in relation to feelings of fatigue, so that opportunities for doing good work shall not be missed because of an erroneous conception that a moderate degree of fatigue prohibits successful work.

Individual variations exist in quantity and quality of production. Some individuals work better for short periods under high pressure; some for long periods at a steady, low pressure. Some work better in the morning and others at other times of day. If one cannot work at one's best until after a long "warming up" period, one should try to arrange to keep at

the work after the productive period is reached. It is wasteful to have to go through too many warming up periods in a day.

There are no rules to be laid down regarding hours or time of work or methods of working. An intelligent individual, if free to do so, can usually work out a schedule adapted to himself. The only caution that is needed is against a schedule that does not permit of a reasonably regular day, and a reasonably long night. Eccentricity in working usually produces eccentric rather than brilliant or valuable work.

It is difficult to be certain whether one is suffering from fatigue at all, when a desire comes on to rest from further physical or mental work. The feeling of fatigue is not by any means absolutely authoritative. There is a state that may be called pseudo-fatigue, because it gives the same sensations and the same disinclination for work, and limits the quantity and quality of work in the same way as genuine fatigue, although not due to work already performed.

Pseudo-fatigue is of two varieties: that which is due to one's physical condition and that which is due to states of mind. In either case it amounts to fatigue feelings that are not due to previous work and are not necessarily dissipated by resting, but often require entirely other treatment.

The lack of validity regarding subjective feelings of fatigue is shown plainly at times in the case of most individuals. Sometimes the individual himself, or others, wrongly interprets laziness, for example, as fatigue; although it should be stated that laziness is often, if not always, a pathological state of either body or mind that, if it is not fatigue, is as much in need of attention.

It is a common observation that a state that seems like fatigue may be present at the onset of a task and disappear after it is well begun. Obviously the feeling of fatigue at the onset may not have been fatigue, if it may be obliterated by more work rather than by rest.

The same is true when excitement and various emotions do away with fatigue. An eminent physiologist says that we have to do with an increased production of adrenin under such circumstances, which activates the body in such a way as to

do away more rapidly than usual with even real fatigue. An additional incentive, such as that furnished by competition either with one's self or with others, may cause a similar result, so that what was thought to be fatigue sinks into the background, having actually been dissipated by the bodily changes due to the greater adrenin production.

It is also noteworthy, as has already been mentioned, that subjective feelings of fatigue after sedentary occupations, such as sitting at a desk, are not necessarily valid as indications of the need of rest. Finally it has often been observed that although it is possible to feel fatigued when one is not really so, the converse is equally true, and one may feel no fatigue even when on the verge of collapse.

The commonest sort of pseudo-fatigue is that which is present in the morning when one wakes up and is less noticeable as the day advances, while at midnight one feels as fresh as one is expected to on arising. Neurasthenics in particular are subject to this strange reversal of ordinary conditions. But there are other states, either of the emotional life or of the circulation, that produce similar results. Often it appears to be due to a general body sluggishness that requires hours of activity to be overcome. If the habit is fixed of sitting up late at night because one is most wide awake then, there is usually a shortening of the hours spent in bed, and a more pronounced sluggishness results from the lack of sleep. The individual is generally better off for going to bed at a fairly early hour, in the expectation that he will eventually get the habit of being wide awake and untired at the same time of day at which others are. The sluggishness that produces morning fatigue is often due to lack of the amount of sleep the individual needs. It is often a vicious circle that may best be broken into by deliberately going to bed even when one is wide awake.

The pseudo-fatigue that is due to physical condition is more likely, however, not to be present in the morning but to come on after an amount of work not sufficient to justify it. Often it is due to toxins in the body other than those produced by activity. Those from the intestinal tract, especially when constipation is present, are very likely to give fatigue that begins in the morning and even gets more pronounced dur-

ing the day, frequently leading to somnolence during the day and pronounced somnolence early in the evening.

Those toxins from any focus of infection may do the same. It is commonly recognized that acute infections often give soreness and fatigue equal to that ordinarily produced by nothing less than a ten-mile walk, even though the individual has been doing no work, perhaps lying in bed. The weakness and tiredness when recovering from illness are sometimes interpreted by patients as the result of having been in bed. They are usually chiefly due to the toxins of the infection, not to lack of exercise. Moving about under such circumstances would make the feeling of fatigue even greater. The weakness after an infection is due to the toxemia, more than to disuse of muscles, as it is sometimes thought.

Chronic infections, such as tuberculosis, not only predispose to genuine fatigue, but in themselves give a lassitude that resembles that following heavy exertion. Pseudo-fatigue, and also genuine fatigue that comes on too soon, may be due to malnutrition or to inadequate circulation. Even without work such individuals may feel physical and mental fatigue, and after even a short amount of work of any kind they may feel exhausted.

The nature of feelings of fatigue should always be determined by means of a physical examination.

The pseudo-fatigue that is psychic, or dependent on states of mind, is often the result of suggestion, sometimes made by the individual to himself, sometimes by others. Perhaps the commonest sort of suggestion that leads to pseudo-fatigue is the comment to an individual that he "looks tired." One should use caution in making such casual remarks, for even the person of strongest mind is likely to be affected by them. At times, it is necessary to comment constructively on a fatigued appearance, but these occasions are very few.

Another way in which individuals influence each other is by commenting on the difficulty of certain tasks. Probably most individuals are more stimulated than otherwise by the idea that a task is hard, but there are suggestible individuals who have all their powers sapped by hearing frequently about how hard their work is. There are always current at colleges

traditions about courses that are supposed to be almost beyond human powers. Whether they are so or not, a certain proportion of students taking such courses will be much hampered in their efforts by the fatigue produced in advance by the adverse suggestions.

The onset of critical times, as for example midyear examinations, suggests so much in the way of possible fatigue that some students actually succumb to fatigue from no more work than they have been in the habit of doing.

The suggestion of fatigue is often made by others, or even by the individual to himself, unwittingly, at times when there is something more pleasant to do than work. All at once one may feel quite too tired to do the unpleasant thing, and feel the need for another form of activity, that is often not less strenuous but pleasanter. It is, of course, permissible to engage in pleasurable activity that is not work for a part of the day, but one should do it deliberately rather than falling back on fatigue as an excuse. In no field is it more important to face facts squarely than in the estimation of the amount of fatigue. Without perfect willingness to face and admit facts, one is more or less at the mercy of subjective feelings that may have no validity.

Pseudo-fatigue is often the result of a lack of interest or incentive in one's work. On the other hand, it may be due to too great interest, that amounts, even, to anxiety about it. The worry rather than the work itself produces a fictitious rather than a real fatigue. Traced to its lair, the anxiety is often due to a lack of sportsmanship, a lack of a willingness to play one's best cards and abide by the consequences. Sometimes it seems to be due to an inherent, although often remediable, lack of the spirit of adventure, which makes craven, fearful cowards in the face of any emergency in the way of extra work.

Many temperamental difficulties greatly increase ordinary fatigue feelings, or even produce entirely fictitious ones. Even the inability to adapt to new conditions of environment, new social conditions and new working conditions may give states of mind that are interpreted as fatigue, and may even suggest the necessity of giving up one's work.

If lack of interest in work is responsible for feelings of fatigue, an investigation may be made of the way one's work is being done.

Possibly the fear of fatigue itself is responsible for pseudo-fatigue as often as anything else. It is recognized that fatigue makes further work impossible, and it is natural to fear it to some extent. One should not give the matter of fatigue too much thought, but merely watch for a degree of it that seems excessive, and get medical advice about it at the beginning.

Many individuals have definite defense reactions against overwork. Usually, although not always, it is a defense against overwork at that which is disagreeable. But some individuals try equally hard to protect themselves against being overtaxed even in pleasurable ways. For the benefit of the fairly large number who are afraid of a breakdown from hard study, and who have a horror of using their full capacities in any way, William James may be quoted: "Most of us get into the habit of living on too inefficient a plane, and could increase our output largely without taxing our organism to the danger point. Of course there are limits, the trees do not grow to the sky. But the plain fact remains that men the world over possess amounts of resource which only very exceptional individuals push to their extremes of use. But the very same individual pushing his energies to their extreme, may in a vast number of cases keep up the pace day after day and find no reaction of a bad sort, so long as decent hygienic conditions are preserved. His more active rate of energizing does not wreck him; for the organism adapts itself, and as the rate of waste augments, augments accordingly the rate of repair. Generally speaking there is little difference in general health between the individual who consistently works up to the point of overfatigue and the one who leaves a large margin."

It should be noted that James refers to "decent hygienic conditions." He no more than any other physician or psychologist would advocate the feverish activity that crowds the day and even turns night into day. It is probably impossible to bring on a nervous breakdown by overstudy alone. A balanced, hard day's work, performed by a well person under

the proper conditions, and with a healthy state of mind and emotions, leads to no impairment of health; in fact it improves health.

To be sure, breakdowns do come to those who study too hard, but upon investigation it will often be found that the individual did not live a well-balanced life, probably that he was not well to start with, that he worked under poor conditions and had a faulty outlook on life.

Breakdowns seem especially likely to come to those who sit up late at night to study, whether this tops off a day full of study or a day otherwise occupied. The logical conclusion usually is that the lack of sleep and not the study was the reason for the break. The person who sits up half the night to study is usually headed for the rocks. To do so occasionally is in itself not necessarily damaging, although if an examination is impending the next day it may be damaging to the examination grade, in the case of an individual who is, as is usual, not at his best except after a full night's rest.

The kind of person who gets into circumstances that make such a procedure, seemingly at least, necessary is one who is usually in other predicaments that interfere with health. He is likely to be a poorly balanced individual who will stray into other bad habits as injurious as midnight study.

On the whole it may be concluded that if breakdown follows excessive study it is due to the associated faulty physical and mental hygiene. The typical "grind" who disregards sleep, scorns exercise and considers recreation beneath him, is usually in many ways an abnormal individual after he has continued the process for some time, and usually was so before he began it.

But there is no resemblance between the true grind and the real student. It is customary to call anyone who studies more than enough to "get by" examinations a grind, and especially to apply this term, although erroneously, to those who frankly admit that they like to study and have intellectual curiosity they enjoy gratifying.

Breakdown is more likely to occur at examination time than at any other. Panic at examination time always indicates bad management somewhere. Those who are the most panicky

often realize wherein their mismanagement lay, which does not help matters if they feel to blame for their plight. There are always some who wish to leave college just before examinations, and some who actually leave, convinced that their fatigue, that has piled up during the term, interferes with the tasks of additional severity that confront them. It should be the aim, of course, to hold in reserve a margin of strength for the special demands, and also to see to it, by care during the whole term, that not too great effort will be necessary at such a time.

The prevention of pathological fatigue is one of the main aims of hygiene. Although it is normal and desirable to work up to the end of physiological fatigue, it is not safe to go beyond that point.

The first step in setting this limit is to learn in advance of engaging in any particular work, how much of it one is likely to be able to do without pathological fatigue. This may be partly gauged by physical examination, and can be further determined by medical consultations after the work has begun. Such examinations and consultations will help one to determine whether the fatigue that comes is physiological, pathological or pseudo-fatigue, and if it is either of the latter, the cause thereof, and the necessary modification of living habits to reduce fatigue to normal. If such consultations are not feasible in advance, they should certainly be had at such times as excessive fatigue appears. One should be particularly suspicious of fatigue that is accompanied by loss of weight or any other symptoms of ill health, and have it investigated promptly.

In the meantime, the experimental method is justifiable. Having adjusted one's self as fully as possible to a mental and physical hygiene regime, one may try to see how much work may be successfully carried on without producing undue fatigue. The best test of ordinary fatigue is the effect of a night's rest. If, after an adequate period of sleep, one feels refreshed and ready for another day, it may safely be concluded that fatigue is not excessive, and that the sleep period was adequate. Consideration of one's state over a longer period is better than day-to-day consideration of it, however, for a small daily accumulation of fatigue might not be noticed. In addition to the

subjective feeling of fatigue that must be watched, the weight, appetite and general well-being should also be watched. All this watching, however, must be done rather casually, without any anxiety, in much the same spirit that one watches one's teeth to see whether they are in condition. Too great anxiety about fatigue, as has been said, is in itself detrimental.

General measures for the prevention of undue or chronic fatigue involve having the body in as good health as possible, and living as wisely as possible. Poor habits that lead to the accumulation of fatigue are primarily lack of sleep, supplying too little time for repair; lack of food, supplying too little substance for repair; faulty excretion, causing retention of toxic waste; too little exercise, giving imperfect circulation and imperfect removal from fatigued parts of the fatigue products. Almost equally important is the getting rid of emotional conflicts, and having the conditions of work as favorable as possible.

Finally, in order to avoid undue fatigue it is necessary that one's life be so planned that the full supply of energy be available for the major interests in life, so that if fatigue comes on it will be the minor activities only that will have to be omitted. Often the prevention of excessive fatigue is made possible if one may stop work at the proper time, which one is less likely to be able to do if important work has been left to the last.

Since work that carries one up to, but not beyond, the point of physiological fatigue increases power, the individual who learns to tire himself to the right degree is learning also how to increase his ability to accomplish still more without undue fatigue.

CHAPTER XXIX

SLEEP AND REST

Sleep may be considered as a temporary suppression of voluntary activity both of mind and body, in order to bring about recuperation of the powers of both. There is often with it a release of lower mental activities in the form of dreams. The desire to sleep is probably due to an instinct—a part of the instinct of self-preservation.

The process of metabolism goes on during sleep as during the waking hours. But there is a difference in the ratio between anabolism and katabolism, the former predominating during sleep. Rest, sleep and nutrition are the main positive factors in living. Both the need for sleep and its efficacy are in proportion to the amount of katabolism which goes on during the day. During sleep the heart beats slowly, respiration is deep and slow, the nervous system is relatively idle and its neurones are being renewed.

It is probable that as many persons suffer from continued lack of sufficient sleep as from any other one cause. They suffer in respect to digestion, susceptibility to disease, and nervous stability. Any bodily, nervous or mental symptoms are more marked if there is lack of sleep. All in all, the health, the appearance, the feelings, the emotions and the quality of work are improved by giving the system its regular, sufficiently long opportunity for rebuilding. In times of illness, the amount of sleep is usually automatically increased and recovery thereby aided. The improvement of nutrition is usually impossible in individuals who cannot or will not take enough sleep.

The amount of sleep that is needed for complete recuperation from a day's work varies in different individuals, according to individual characteristics and the type of strain produced by one's activities. Enough is needed to make up for the day's

wear and tear, whatever that amount may be. Depth of sleep is a factor of importance. The benefit of sleep is not always in proportion to its length. Individuals who seem to get along well on a small amount of sleep probably sleep very soundly.

The average amount that seems to be needed—judging by the reports of adults who keep in good condition—seems to be about eight hours. Those who take life easily may need less. On the other hand, those who take life easily often seem to be able to do so because they do get enough sleep; whereas those who are intense seem often to be so because they get less sleep than they need. A high strung individual at his best usually needs a great deal of sleep: a phlegmatic one at his best usually needs less.

A person should find out, by experimentation, the amount of sleep he needs, and should get that amount. If that amount must be diminished one night, it should be made up the next day, or as soon as possible. The effect of lack of sleep is often immediately observable, although unfortunately it often does not appear on the day following, but somewhat later. This leads to confusion regarding the matter. It may seem that going without sleep has had no ill effect. If observed over a considerable period, the difference in health due to the loss of an hour of sleep a night may be more readily perceptible. Such a lack continuously may make all the difference between health and the lack of it, or between being able to do what one wishes and not being able to do so.

If sleep must be curtailed, it makes comparatively little difference at which end it is curtailed, although getting up early in the morning and studying before eating does not seem to be particularly successful in most cases. Moreover, it tends to unsettle the usual waking hour. The main point, however, is to get sleep when it is needed. If fatigue comes on early it is better to go to bed early, and then to get up early if necessary.

Generally speaking, if one must get up at a certain hour there should be few postponements of the retiring hour. Although it seems like a clear gain to sit up late at night to study, this is usually not the case. Education is not entirely dependent on the amount of time spent in study; in fact it

is still more dependent on the quality of the intellectual processes. It is easily possible to affect the quality of one's work so adversely by spending more time on it, that one is less well off than one would have been after a shorter period of study. "Burning the midnight oil" may, after all, amount to thwarting one's aims by interfering with the clearness of the thought processes that may be brought to bear on a task.

There are those who seem never to be able to get enough sleep. They fall into five groups. First, there are those who are affected by toxins other than those of fatigue, such as those from the intestines or the tonsils. The cure is to find and eliminate the source of the toxin.

Second, there are those who exhaust themselves so much during the day by their excessive physical and mental activity, that they require a long period of recuperation. For these the cure is often a less active life. Such fatigue represents either a good constitution taxed by too much activity, or a poor physique affected too much by an ordinary day's routine.

Third, there are those who are sluggish, whose bodily processes are slow, and who recuperate slowly after ordinary activity. They may often be helped by measures to activate the circulation during the day and before going to bed. Such individuals are usually overweight; whereas those in the second group are usually thin.

Fourth, there are those who have a weak spot subject to particular strain. The automatic device for resting the weakest part is often the prolonging of sleep. This is particularly true in the case of eye strain, which may give disturbed sleep, and often necessitates a good deal more sleep than would otherwise be necessary.

Finally, there are those whose sleep is less deep and satisfying and more prolonged because of poor conditions under which they sleep. An uncomfortable bed—particularly a sagging one—too warm a room, and many other factors may decrease the depth of sleep.

Difficulty in going to sleep may be due either to physical or mental states or to environmental factors. The physical state that most often interferes with sleep is cerebral hyperemia or congestion of blood in the brain. It may follow excitement,

or too short an interval between study and going to bed. If one is conscious of it, it may be relieved by a small amount of general exercise or by bathing the face and neck in cold water. A little brain fatigue seems to be just what many persons need to put them to sleep, however.

The presence of too much or too little food in the digestive tract may delay falling asleep sometimes. It is generally better not to eat much just before going to bed, for, although sleep may follow rapidly, it is likely to be less sound. Furthermore, repair processes do not go on so well when much of the blood is being used in the digestive tract during the night. Sometimes a small amount of food or a hot drink relieves cerebral congestion and promotes sleep. Other factors also often delay falling asleep. Very hot baths usually cause

Fig. 210.—Resting with pillow under the back, so placed as to favor expansion of the lower chest.

wakefulness, as do also cold ones, whereas warm ones are soothing. Coffee is often said to keep one awake. Usually the wakefulness seems to be the result of expecting it, however. Those who have an idiosyncrasy should be guided by it. Cold feet often provide sufficiently strong sensory impressions to keep one awake. There is no virtue in bearing such a condition. If the circulation cannot be made adequate in the feet, then warmth should be applied. Too much or too little physical fatigue may prevent falling asleep promptly. In either case nervous fatigue may be a prominent contributing factor. The warm bath helps when fatigue is too great; and a little exercise when there is not sufficient physical fatigue. Putting the hands behind the neck and taking a number of long, deep breaths stretches the diaphragm and relieves the congestion that may have followed a cramped position at work. If there is difficulty in getting to sleep, lying on the face, or assuming a

position known as the "knee chest" position for a few minutes may help.

Mental states that interfere with falling asleep are of several varieties. They include two opposite conditions—too much

FIG. 211.—Knee-chest position. Note right angle at the knees.

monotony of thought and too much excitement. If the mind is tied too firmly to one line of thought, it may be hard to disengage it. Sometimes there is actual unwillingness to let go the absorbing subject. What is needed is a sharp break,

which may be furnished by almost any sort of light reading that is not in itself too absorbing. On the other hand, if the mind is in a whirl because of very diversified interests, it may be difficult for it to settle down. The flow of ideas needs to be stopped. This, too, may often be accomplished by light reading of indifferent interest.

One of the most common attitudes which prevent sleep is the fear of not sleeping. Having missed going to sleep promptly for a few nights, and having tossed and turned uncomfortably, there may naturally arise a fear that this is going to be a habit. Sometimes it is a fear that one is going to be like a parent who had similar difficulty. It amounts to implanting unfavorable suggestions, and, as one fears, sleep does not come. The remedy is, of course, the recognition of the cause of one's sleeplessness, and the expectation of sleeping.

Worry is often given as a cause of delay in going to sleep. Of course it is a mistake to set apart, as many do, the time after going to bed for the review of one's past and the planning of one's future. There are times to look over the past, to regret some of it and learn from it; and there are times to survey the future and plan for it, even to be moderately, healthily anxious about it. But these times are not those that should be dedicated to sleep. The attitude during most of life should be to accept the past, not to regret it; to accept the future, not to be anxious about it. Surely if sleep is to be what it ought to be, the attitude of acceptance is the one to adopt after going to bed.

The most favorable state of mind after retiring is one in which there is very little voluntary direction of thinking at all. Counting, or reciting poems, or other devices that involve mental effort, seldom succeed. If possible, the mind should be allowed to wander idly through mildly pleasant paths, the only voluntary effort being made to start it in the right direction.

The determination to go to sleep is just the sort of voluntary attitude that prevents sleep. One must give over willingly the feeling of responsibility and adopt a "don't care" attitude, whether one does care or not.

After all, the rest one gets while lying in bed before sleep comes is nearly if not quite as good as sleep, providing one is

in a quiescent state, not striving for sleep or for solution of all one's problems. The aged, who sometimes do not sleep well, learn to utilize all their pleasant memories for securing quiet and calm, if not sleep. Those who realize the importance of sleep sometimes try so hard for it that they miss the benefit of sleep itself, and of the rest that might almost take its place.

Insomnia is often due to a generally maladjusted restless life. It is often necessary to set one's moral and spiritual and emotional life in order, as well as one's physical life, before sound sleep can be regularly obtained.

Environmental factors that interfere with sleep are usually of the nature of noise, light or undue warmth. Keeping the light burning after another is in bed in the same room is a form of cruelty of which roommates are often unthinkingly guilty. The ethics of such a situation is that the one who wishes to remain awake latest should give way to the one who wants to go to sleep at the usual time, and go out of the room if it is necessary to do any late studying.

The individual who is so susceptible to ordinary noises that he is thereby prevented from sleeping, should in self-defense learn to ignore them. This may be done by assuming an attitude of irresponsibility for them. It is not the noise itself but its personal significance that seems to matter. Most noises (such as ticking clocks) have no bearing on one's affairs at the time they are troubling. If this is recognized they usually cease to annoy.

The temperature of the room is of great importance, for most individuals will be kept from sound sleep by too warm a room or by too many covers. On the other hand, cold stimuli may have as great an effect.

Insomnia may take the form of too early waking. Sometimes this may be attributed to physical sensations that arouse one. Sometimes it is due to a fear of not waking on time. When this is the case, one should set an alarm clock and then cast off all responsibility on to it.

Although physical, mental and environmental factors may influence sleep in pronounced ways, it is possible to cultivate so strong a habit of going to sleep promptly upon retiring that no ordinary conditions prevent it at all. There are two great

aids to the forming of this habit. One is that of regularity in sleeping hours. The other is the habit of prompt release of one's self to sleep. In so far as it is possible, one should have a regular hour for going to bed and for arising. Both the body and the mind become accustomed to the rhythm thus established. If the regular hours are too frequently changed, the effect of this rhythmic tendency is lost. The second factor in habit formation—the release of one's self to sleep—is still more important. The word "release" is chosen to express both the physical and mental attitude that is most favorable, and that should become habitual.

There is no particular position that is most favorable for sleep, providing the body is not doubled up and cramped so as to interfere with circulation. Relaxation is possible in many positions, but is perhaps easiest while lying flat on the back without a pillow.

Drugs should not be taken to promote sleep except in emergencies when sleep is very important to health, in which case they may be prescribed by a physician. They may also occasionally be prescribed to establish the habit of sleep. Opiates are almost never used except occasionally in serious illness. There are other drugs less harmful and as effective.

Dreams are the result of the activity of the part of the mind that is not conscious, although the conscious mind is able often to grasp the dream and remember it. The content of the dream is usually apparently meaningless. Often it seems to bear some relationship to things that have happened during the preceding twenty-four hours. It is now quite generally thought that dreams have significance. Psychoanalysts investigate the content of the unconscious mind partly by examining the dreams; but this is a skilled procedure, not one that the layman can perform for himself or his friends. The manifest content of the dream (what it apparently means) is never at all like the latent content of it (what its symbolism really means). Dreams should either not be taken seriously at all, or submitted to a psychoanalyst. It is not to be considered abnormal if one dreams apparently every night and all night, for this does not necessarily interfere with good sleep. Nor need one be alarmed by dreams that seem not in

accord with one's personality. One is likely not to figure very imposingly in dreams.

Walking and talking while asleep are also manifestations of unconscious mental activity. Ordinarily a physician, especially a mental hygienist, should be consulted, because such habits, which are sometimes disturbing to others, should be stopped.

Rest consists of a lesser degree of diminution of activity than sleep, although it is for the same purpose—the counteracting of the effects of activity and the getting rid of fatigue toxins. A certain amount of rest during the day is as necessary as sleep at night. There seem to be two classes of persons—those who care too much for rest and those who care too little for it. Usually it is those who care too little for it who need it the most. It is rather rare to find an individual willing to work reasonably hard and to rest reasonably thoroughly. Unwillingness to rest is often due to an attitude carried over from more ascetic generations. Very many believe that every waking hour should be fully occupied, and that rest is a waste of time. It must be realized that rest is a positive factor, not a negative one.

Rest is not merely not working. It is cessation of voluntary activity; but it represents the time when the most constructive acts of the body itself are performed. It is the performing on the part of the body of its most fundamental function, that of building itself up. To the body, rest is the time of greatest production, although to the person who is resting nothing appears to be going on. It is hard to get a right concept of the constructive nature of rest in a world where outward manifestations of energy are of so great importance, and where the nature of cell activity is so little understood.

Rest should also be differentiated not merely from not working, but from a change of occupation, even to one that seems more restful. There is a place of great importance for recreational activities, and they often prove restful compared with the continuance of work. But they should be undertaken at times when it is realized that recreation and not rest is needed. It is a mistake to confuse the two. All activities, recreational and otherwise, represent expenditure of energy,

and are thus in the main katabolic rather than anabolic. The chief reasons for conversation or bridge-playing in one's rest time are psychological or social ones, which may, of course, be fully as important as the need for rest. If it is recognized that they are possibly restful in effect, but are not actually rest, it is unlikely that unwise changes of occupation will be substituted for genuine rest.

The chief type of change of occupation that definitely favors rest in other than psychological ways is represented by a change from sitting still to moving about. Although increasing the production of fatigue toxins, the effect of muscle exercise in such circumstances is to increase circulation also, so that both the newly produced fatigue toxins and those produced by sitting still are better disposed of. A reasonable amount of exercise after sedentary work is thus actually to some degree a method of resting, or at least a desirable preliminary to rest.

Sometimes rest does not seem to do what it is expected to. This is because it is not real rest. In order to be satisfactory, rest should follow work and should be complete. A continuous semi-siesta that goes on through lectures and recitations is not ideal as rest, to say the least. It is desirable to work while working and to rest while resting.

A satisfactory rest is not necessarily long. In industry it has been shown that several short interruptions of work are better than one long one. In mental work, five minutes' rest in each sixty is usually all that is needed. If long rests are taken, too much "warming up" is required when work is resumed. However, the observing individual should be the judge of the amount of rest that is profitable. In order to be a real rest, no physical or mental work should accompany it. Both body and mind should be relaxed and at ease.

The best rest can be obtained while lying down. Soldiers on long marches seem to find that physical endurance is greatly increased by stopping a few minutes every few miles to lie flat on the back. This position may be made still more effective as rest if a pillow or similar object be placed under the lower chest. This tends to promote respiration and circulation. Putting something under the knees tends to

flatten the lower back and relieve the fatigue there. If there is a tendency to ptosis of the abdominal organs, a pillow under the hips tends to counteract the effects of the customary position. If the posture is poor, and fatigue consequently more marked, these various positions should be tried.

It is particularly beneficial to rest a short time both before and after meals. If convenient, this is better done lying down. The chief benefit of such a practice is that rest taken in close proximity to meal times improves digestion and nutrition, and that it ensures regularity of rest periods.

A certain great man, who has given the world the wrong impression about the need of sleep because he gets along on very little sleep at night, is said to be able to rest very com-

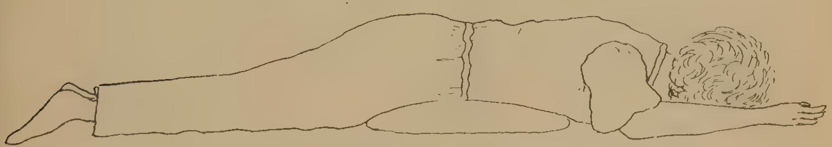


FIG. 212.—A pillow under the abdomen to minimize the lumbar curve when sleeping on the face.

pletely for short periods during the day. It is reported that he not only can completely relax many times during the day but that he falls asleep easily at such times, waking after a few minutes ready for a continuance of his intense application. This is a desirable habit to have, if it does not result in too long day-time naps that interfere with sleep at night. It is usually, probably, wiser to do one's sleeping at night, and reserve the napping for days on which the night sleep has been unavoidably broken.

The signs of the necessity for rest should never be masked by stimulants. It seems to be thought that stimulants do away with the necessity for rest, but such is not the case. They simply make the fatigue less apparent. After their use, the individual may mistakenly continue activity to an unsafe point. The psychic stimulation of excitement may have the same effect as drugs.

While one is using care not to goad one's self too far, by laudable ambitions or otherwise, care must also be used about not goading one's self enough. Much discrimination is needed in life to be certain that one is not yielding too readily to the impulse to rest, or that one is not disregarding such impulses too completely.

The health of the body is not by any means in proportion to the amount of rest taken. If there is not enough katabolism failure of powers results as surely as when there is too much katabolism. Cells gain by use and by the sufficiently rapid interchange of old blood for new.

There is difficulty in determining the exact degree of fatigue that calls for rest, and the exact proportion of each day or week or year that should be spent in rest. The trial and error method should be used to determine the results of a little more or a little less real rest.

CHAPTER XXX

THE HYGIENE OF THE CIRCULATORY SYSTEM

The purpose of circulation being to supply all cells with whatever they need and to take away from them whatever waste they produce, and to carry valuable substances made in one part of the body to other parts of the body, it will be evident that hygiene should include definite efforts toward keeping the circulation generally active, in order to make possible the necessary unequal distribution of blood to working and resting organs, and to avoid any distribution that is unnecessary or harmful.

Lowered general efficiency of the circulation is usually accompanied by faulty distribution of blood. One of the common signs of poor circulation may be, for example, cold, clammy hands and feet. The signs of poor circulation may be found in any organ, and if present at all, are likely to be found in many organs, because the defect in circulation is usually general. There is likely to be disturbance of the digestive or other systems, and of the mental and emotional functions. The color is likely to be poor, and the skin not clear. There is likely to be fatigue and shortness of breath, and a tendency to faint. The individual who has a number of signs of ill health may possibly owe them all to the same cause—faulty circulation through the body, and the resulting interference with cell nutrition and organ activity.

The hygiene of the circulation involves the care of the organs that maintain it—the heart and blood vessels—and the care of the circulatory process itself. It also involves the maintenance of the normal characteristics of the blood.

Even though the heart, the blood vessels and the blood are normal, circulation may yet be disturbed, giving a condition of functionally faulty circulation, since it does not depend on

any structural or organic condition in the circulatory system. It will often be found that it depends either on nerve stimuli that are at fault, endocrine excess or deficiency, muscle exercise in excess or insufficient, or posture such as to hamper circulation.

By far the largest part of circulatory difficulty in young adults is functional and depends on these causes. When the nerve stimuli are at fault, it is likely to be in an individual who is overindulging in emotions. Sometimes the effect is to make circulation uselessly too active and to produce strain of the heart and even an increase in blood pressure. Sometimes the nerve stimuli are at fault because of general poor tone of the nervous system which affects the nerves that govern the heart. The "nervous heart" is accompanied by an erratic circulation. It usually suggests the desirability of revising many habits, both physical and mental.

When it is the endocrines that are affecting circulation adversely, it should be recognized and appropriate hygienic or medical treatment carried out. An increase in circulatory activity due to increase of thyroid secretion is frequently found in young adults. The reverse also is common, a general sluggishness that may not be overcome by any means except correcting the endocrine disorder.

Most common of all causes of poor circulation is too much or too little muscle exercise. Muscle exercise increases the rate of the heart and hence of the circulation, and by pressing the blood in the veins toward the heart increases the amount of blood the heart handles in a given time. By increasing depth of breathing it adds a suction effect on the blood in the veins, bringing it back toward the heart. Exercise is the best activator of circulation. Whereas enough exercise is beneficial, too much might be detrimental. The effect of cold bathing is similar in some respects to that of exercise.

Finally must be considered the effect of posture on circulation. If posture is bad, it is likely to be so in respect to the chest. As the antero-posterior diameter is decreased, the heart is pressed upon and cannot do its work as well. Furthermore, the heart may actually be found sagging lower than usual

and causing still greater impairment of its pumping power. This occurs when the diaphragm is low because of a slouching position of the body.

The correction of the posture is one of the first steps in making sure of a good circulation; the use of appropriate amounts of exercise, the second. Because a poor circulation may have other causes—such as disease of the heart or the blood vessels—no measures should be taken without medical advice, if symptoms of circulatory inefficiency are actually present, beyond correction of posture and regulating the general hygiene. The taking up of increased activity or of special kinds of baths, when circulatory defect is suspected, should be done only after medical advice has been received. Even the correction of posture and general health habits is better done after advice if symptoms are present, particularly if one is planning work of any kind which puts heavy demands on the circulation. If the circulation seems to be good, all efforts should be made to keep it so by using the circulatory power freely.

The term "anemia" is used to describe a relative lack of blood in a part. Hyperemia is a term that indicates more blood than normal in a part.

Fainting is a common ailment in which the circulation to the brain is temporarily reduced—the brain being "anemic" at the time. Dizziness on getting up from a sitting or lying position represents the same condition. It means that the blood either has not promptly left its reservoir in the great abdominal vessels to supply the brain with blood, or has been drawn by gravity away from the brain. The circulatory adjustments are not easily made in all persons. Imperfect adjustment is common in debility, during periods of convalescence, in states of starvation, on overexposure to heat or to sudden change from cold to heat, during pain (sometimes at menstrual periods), after overexertion, or after too long exposure to "bad" air. Fainting may occur from any of these causes, or sometimes from mental causes only. Unless there seems to be some obvious explanation for fainting, there should be some question of the general health. It is usually not due to heart disease.

Anemia of the digestive tract occurs during exercise and such bathing as causes the muscles and skin to become hyperemic. There is probably some degree of anemia of the alimentary tract during the hyperemia of the brain in concentrated brain work. One should ordinarily allow a short interval to elapse between a very hearty meal and any activity that would tend to take a large amount of blood away from the digestive tract.

Hyperemia may not be due to the actual need of more blood in a part, but to its damming up there. This is passive hyperemia. The internal organs may be affected in this way by disease processes in them—especially those associated with chronic alcoholism. Congested, passively hyperemic parts are poorly nourished, because the blood flows so slowly through them. The proper cells are not nourished and connective tissue cells may grow in their place.

Edema means the oozing out from the blood of some of its fluid into the spaces between the cells. The part swells. It is noted in the tissues where injury has occurred, such as sprains; or in areas where there is inflammation, as in the nose in a cold. Edema of the nose or throat is often the first sign of a cold. Whenever these mucous membranes seem swollen, it is desirable to take precautions as though a cold were coming on. Edema of the ankles, when not due to injury, is sometimes associated with disturbed kidney function. But it may be due to poor use of the feet, or to a generally faulty circulation that fails to bring the blood back from the feet promptly. A part of the body that is swollen may be so because of edema or the swelling may be due to some other cause. In any case, a part that is swollen is in some way not normal, and should receive medical attention.

Since the chief organ for the maintenance of the circulation is the heart, its care is of the utmost importance. There are several aspects of the care of the heart. Its hygiene involves, first, its training as a muscle, for it is the most important muscle in the body. Adequate strength of the heart muscle is necessary in order to have adequate circulation to each and every cell of the body. It may be trained to a high degree of power, or it may be allowed to get very

weak, or more rarely it may be weak because of disease. Whatever its strength, its hygiene involves two things: first, adapting the demands made on it to the amount of strength already attained, and, second, making its strength sufficient for the demands one would like to make on it. The right amount of exercise helps the heart, and the wrong amount either allows it to deteriorate, if too little is demanded of it; or allows it to be strained, if too much is demanded of it.

A normal heart has considerable reserve power and can do unusual things without damage. It is even possible to get winded and then to develop "second wind." Getting out of breath, or "out of puff" as the English say, is due to the effort of the respiratory system to supply the tissues with oxygen more rapidly. They do not get enough oxygen when exertion is being made if the circulation is not active.

When the rate and amount of circulation are less than the occasion demands, respiration is quickened and deepened. The same principle applies when the red cells of the blood have too little oxygen-carrying power. Those whose red cells are inadequate in number or quality therefore get out of breath easily. The difficulty of breathing seems to an uninformed observer to be related to lung conditions, and it may be so; but it is much more likely to be due to circulatory and blood conditions.

It is thought that it is not possible seriously and permanently to strain a normal heart by long continued or severe effort unless there is infection in the body at the time—either acute, such as a cold, or chronic, such as infected tonsils. In all infections the heart muscle is more or less involved. A heart that is not normal is, however, likely to be seriously injured by overexertion, and still more likely if infection is present. If trouble follows severe muscular effort, it means usually that the heart was weak, a condition perhaps not suspected by the individual; or that temporarily a known or unknown infection made it unfitted to bear strain.

A weak heart can perhaps do a usual amount of work well, or a modified amount of work, but cannot stand anything beyond its limits, which may be and should be thoroughly

understood by its owner. It should be repeated that its reserve may be raised by regulation of living generally, and by muscle exercise that involves heart-muscle training.

Parallel in importance to prolonged or severe physical exertion is the strain put on the heart by disease. One of the reasons for trying to have a well developed heart is that such disease emergencies may be well met. During illness that produces fever there should be no exercise by those with feeble hearts, and very little even by the normal. Bed is the best place when ill, with even a cold. No extra demands, and as few regular demands as possible, should be made on the heart even during slight febrile attacks or infectious diseases.

The effect of not heeding this principle regarding the care of the weak heart is likely to be a dilatation of the heart. The muscle relaxes and passively stretches, losing its contractile power. Unless such a condition terminates in disease of the heart or death, the heart may slowly regain its tone. Having dilated once, it is likely to do it again, unless the care that should have been taken before is taken in the future. A state of the heart that would possibly lead to dilatation may usually be recognized at physical examination, at which time the individual is restricted accordingly. Dilatation is more likely to occur in the weak heart during convalescence from infectious disease, because the heart is affected by bacterial toxins and by the necessary inactivity during infection, if the illness has been a long one.

The individual who has once seriously overtaxed his heart, thereafter may not be able to exert himself without discomfort. The term "wind-broken" is sometimes used to describe this state.

Even for the normal individual it is unwise to undertake too much exertion when "out of training." Heavy athletics and sports should be prepared for by a period of gradually increasing activity. In any individual who exercises rarely, and then too much, some embarrassment of heart action is likely.

The care of the heart involves the care of the lungs. When they are diseased, the heart has more work to do to pump the blood through them. The care of the heart also involves the

care of the excretory system for the same reason, and also because some forms of waste, that should be gotten rid of but are retained, poison the heart muscle.

Its care also involves adequate nutrition, for the heart muscle suffers quickly from lack of nourishment. The effect of rest and sleep on the heart has already been referred to as being important for the saving of heart beats. Each heart beat represents raising two pounds one foot. Going to bed at ten instead of twelve saves about 800,000 foot pounds of heart work in a year. Even lying down half an hour a day saves 200,000 foot pounds a year. The heart need not be saved too much, but if saving it is necessary, additional recumbency is one of the best ways.

Heart disease is, like all disease, either functional or organic. Functional disease resembles organic disease in some of the symptoms it causes—lack of wind being the chief one. Functional heart disease may be due to many causes, and should be curable if the proper methods are pursued. Sometimes functional disturbance requires only more rest, or more suitable exercise, or better posture, or better diet.

Depression of heart action by drugs is the cause of one of the more serious kinds of functional disturbance. If the drug is taken habitually, the condition may be more or less chronic; or it may come on suddenly after a single dose. The coal-tar products, such as acetanilid, are particularly likely to do this, if used in doses unsuited to the individual. Great care should be used in taking unknown headache or pain remedies in particular, for many of them contain heart depressants. Even some of the drugs that are commonly taken are not entirely without danger. Serious overstimulation of the heart is also possible.

Organic heart disease in those under middle age is usually due to infection of its muscle or its valves. The germs that are most likely to do this are the germs of tonsilitis, of rheumatic fever, of scarlet fever, of pneumonia, or of the venereal diseases. That type of heart disease due to syphilis may even occur before birth. Any of these infectious diseases of the heart may be acquired at any time in life. They may be the accompaniment of acute illness, or they may be the result of

chronic infected areas in the body, such as, in particular, infected tonsils and teeth.

A considerable proportion of heart disease originates in childhood or youth. As the blood containing bacteria flows through the heart, the bacteria may be caught on the valves and set up inflammation there. Certain kinds of bacteria seem to have a special predilection for the heart valves—especially certain varieties that grow in the tonsils. Such bacteria at the same time are likely to involve the joints to a greater or less degree—sometimes causing rheumatic fever.

	Cardiacs		Non-cardiacs	
	Number	Per cent	Number	Per cent
Tonsillitis	82	64	55	18
Rheumatism	57	45	16	5
Measles	45	36	176	58
Pneumonia	23	18	14	5
Diphtheria	21	17	27	9
Chorea (St. Vitus' dance)	18	14	1	..
Pertussis (whooping cough)	17	13	100	33
Scarlet fever	16	12	14	5
Influenza	2	..	17	5

FIG. 213.—Comparison of history of occurrence of infectious disease of cardiacs and non-cardiacs.*

Several things may happen to the heart valves so infected. The inflammation may entirely subside if the individual is kept absolutely quiet until this has happened and the valves are healed. Or the condition may be unsuspected and not adequately cared for, in which case the valves will be partly destroyed. Or the infection may be so great that this happens regardless of care. Or the individual may not recover from the attack at all. The most common result is recovery from

* Abstracted from a table presented by Dr. R. H. Halsey in an article on "Heart Disease in Children of School Age," Journal of the American Medical Association, August 27, 1921. The statistics were based on a study of New York school children. It shows the prevalence of certain diseases in the history of those with cardiac disease.

the first attack, with healing of the valves but not restoration to their former shape and efficiency. But this is not always a serious handicap, as will be shown.

Valves that are so diseased either do not open completely, or they do not shut completely. In either case, the regular rate

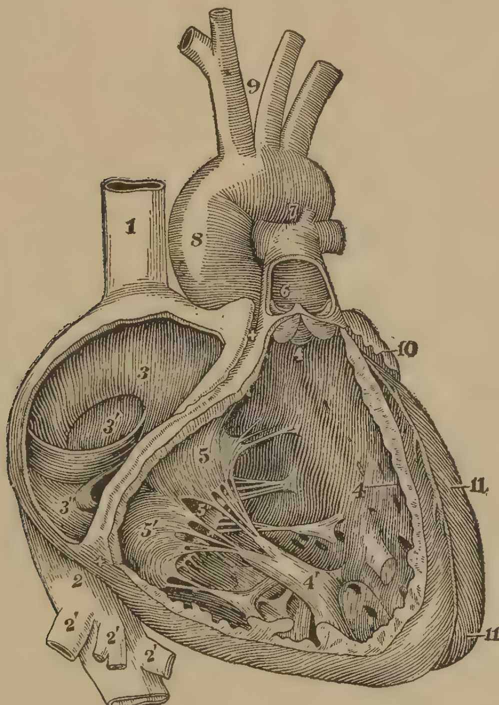


FIG. 214.—Interior of the heart. 1., superior vena cava; 2., inferior vena caval 2'. hepatic veins; 3, 3', 3''., wall of right auricle; 4., right ventricle; 4'., papillary muscle, to move the valves; 5, 5', 5''., flaps of tricuspid valve; 6., pulmonary artery (artificia; opening); 7, 8, aorta; 9., its branches; 10, 11, left auricle and ventricle. (From Yeo after Allen Thompson.)

of flow of the blood through the heart is interfered with. If a valve does not close completely behind the blood that is pumped out at each beat, some of the blood leaks back, and the valve is called "leaky." The heart chamber must pump out not only 100 per cent of what it contains, but also the 10 per cent that leaks back. The heart has more to do, and in

order to do it, it grows stronger. This is called compensatory increase in size, a process that sometimes takes years after infection to become perfect. In this type of valve disease the heart is larger and stronger than normal, but the result of its extra work is only the same degree of circulatory efficiency obtained by the normal heart with less work. Since the heart is already working harder than usual, it has less reserve power to call on for extra strain.

The heart whose valves are leaky may not succeed in developing enough additional power to accomplish the same circulatory result accomplished by a normal heart. It is then that

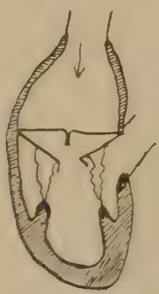


FIG. 215.—Diagram to show the control of the heart valves by muscles attached to cords.

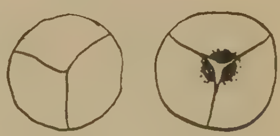


FIG. 216.—Normal heart valves tightly closed; heart valves showing infection and incomplete closure.

it needs training. An individual with a leaky valve should have circulation quite as good as one with a normal heart. The only difference that should exist between a compensating heart with valve disease and a normal heart is in the amount of reserve each has for emergencies. The compensating heart is, however, a sick heart and should not be overtaxed; nor should it be undertaxed, or it will lose its valuable increase of muscle power. A considerable number of individuals have sick hearts and are able to do anything they want to do, because they have trained their hearts carefully to meet gradually increasing demands. Sometimes they are actually able to do more than those with structurally sound but untrained hearts. The efficiency of the heart depends not only on close-fitting, non-

leaky valves but on its muscle quality, for the heart must be able to pump the equivalent of about ten tons of blood a day.

One of the important aims of physical examinations is to determine not only how much an individual should be restricted, but how much he ought and must do to keep a normal or even a damaged heart well. Considerable care should be used in the choice of occupation in life with the knowledge of the heart's condition in mind. If well chosen, the individual with valvular disease may gain complete compensation and keep it, and have a right to expect a life as long as the normal. In women, it may be noted, there is usually no reason to expect bad results to a damaged heart during pregnancy.

Bad effects do, however, follow exceeding one's limits, either a little constantly, or a great deal at once. Disease taxes all hearts, and taxes the damaged one more than others. The result is either the dilatation already described, or a slow failing of circulation with the resulting congestion of various organs. Particular care should be taken by those with heart disease to avoid infections, any of which may reduce heart muscle power or may set up more inflammation on the already diseased valves. The individual with valvular disease also should avoid the taking of any medicines unless prescribed for him by one who knows his cardiac condition.

The individual with heart disease should particularly avoid worry about himself. Probably as many individuals with valvular disease live well and long as do those with normal hearts, providing they live wisely. Worry affects the action of the heart adversely and makes the individual guard himself from exercise more carefully then he needs to. If he lives rationally, and is under occasional supervision, he has little to fear. It is the fearful individual who overprotects himself—or vice versa, braves it out and uses no care—to whom trouble comes.

Another psychological attitude toward heart disease should be mentioned. A large number of individuals erroneously believe they have trouble or are going to have trouble. This is often due to misinterpretation of what has been said to them, or of restrictions placed on them. Sometimes students whose hearts are enviably sound have heard the word murmur men-

tioned during examination and have thought the physician meant heart disease. A "murmur" is a sound produced in the heart in a number of different conditions. In a large number of cases it is not caused by heart disease, and has no special significance. Individuals are restricted in activity for many reasons, the commonest of which is undernutrition. It is borrowing trouble to conclude that either murmurs or restriction of exercise means heart disease or the suspicion of it.

Some individuals think they have heart disease because they have palpitation, pain in the chest, or fainting attacks. In the vast proportion of cases these symptoms indicate disturbance elsewhere than in the heart. The pain in the chest is more likely to be in the stomach, and the other symptoms more likely to be due to fatigue, "nervousness," anemia, or undernutrition.

Some individuals believe they have heart disease by inheritance. Heart disease is not hereditary. It is possible to inherit a potentially weak circulatory system; and it is possible to be born with a congenital defect in the heart, but the importance of these is far less than the importance of very many causative factors of heart disease, notably infection. A very large majority of cases of heart disease are to be prevented by preventing or properly caring for infection.

Some individuals think that they have heart disease because they are overweight and get out of breath easily. They may be right—for excess fat may embarrass or injure the heart. But their lack of wind is likely to be due to the disproportion between the power of a normal but flabby heart and the weight of a large body that must be moved about. The remedy for both is graduated exercise and regulation of the diet together with whatever medical treatment may be indicated.

The hygiene of the arterial system involves consideration of the blood pressure. Individuals vary widely within normal limits in respect to blood pressure. Not all high or low blood pressure is abnormal. There is, however, a state of pathological high blood pressure that interferes with good health. The individual whose blood pressure is high should endeavor, by regulating his living, to get it nearer to customary standards. If its lowering cannot be accomplished by these means, under

medical guidance, he should, while living as wisely as possible, cease to be worried about the blood pressure, for it may be for him normal. The same applies to low blood pressure, which should be corrected by correct living habits if possible.

The factors in the daily life that cause blood pressure to be higher than normal include, first, too great and prolonged and repeated physical exertion. The blood pressure rises during exercise. If exertion is excessive and continued, the blood pressure may remain high. Second, too great and prolonged and repeated emotional stress raises blood pressure. It rises during excitement and many emotions allied to it, and may continue at a high level if the emotion is habitual or recurrent. To protect the arterial system from the results of high pressure within it, both physical and mental hygiene must be utilized. The individual whose blood pressure tends to be high particularly needs an adequate amount of sleep.

Blood pressure is found increased in some disease conditions, notably in some sorts of endocrine disorders, in some but not in all types of heart disease, and in some conditions of poisoning (e.g. lead).

Physiologically blood pressure is lowered in most states of feebleness. Avoiding undernutrition and overfatigue helps the body to regain its tone, and the blood pressure to become normal. Rest and sleep are as beneficial for low as for high blood pressure. The individual with habitually low blood pressure usually does not feel very energetic and tires easily. Every effort should be made by the means mentioned to raise the blood pressure to normal, for the adequacy of cell nutrition depends to a considerable degree on this factor in circulation. Blood pressure is often found decreased in certain sorts of endocrine disorder, heart disease and posioning.

There is commonly found in the same individual an increase in the size of the heart, stiffness of the blood vessels, impairment of kidney function and high blood pressure. The degenerative diseases, that are so often spoken of as important causes of death at middle age, and as conditions largely preventable by hygiene, usually include all of these defects. They constitute what is known as a "vicious circle," in that

one leads to the other, and that to the next, the last to the first again, and so on. They do not always appear in the same order, and, in fact, it is often difficult to determine where the circle began, for the individual often has all four ailments by the time he seeks advice.

It is one of the most important aims of preventive medicine to reduce the frequency of this group of degenerative diseases, from which the death rate is increasing today. Unfortunately, the prevention is not simple. Practically everything that has any bearing on life has a bearing on these conditions. There is no aspect of hygiene that can be neglected if they are to be prevented.

High blood pressure has a relation to the beginning of the circle sometimes, because continued high blood pressure from any cause may bring on the complete train of events. Several forms of heart disease or kidney disease are capable of starting the circle. Degeneration of the arteries may be the beginning.

Virchow said that "a man is as old as his arteries," meaning that old age comes—with degeneration of many organs, as in senility—when the arteries cease to be elastic. The cause of loss of elasticity is often continued high pressure in the arteries, which tires both muscle and elastic fibres. They lose tone, and deteriorate. They are then replaced by connective tissue, which does not serve the purpose of arteries as well as does muscle and elastic tissue. The next step is the deposit of calcium in their fibrous walls, with the "hardening" of the arteries so commonly heard of. Whereas this process is normal in old age, it is abnormal at or about middle age when it often occurs.

Arteriosclerosis may follow other causes than high blood pressure. The arteries may deteriorate as described because of poisons from without (e.g. alcohol, or lead) or poisons from within the body (e.g. intestinal tract). Or they may deteriorate because of slow absorption of bacterial toxins (from teeth or tonsils, for example, or from syphilitic lesions especially).

If the vessels of the kidney are hardened even a little, the kidney does not work as well in excreting poisons. These poisons cause more hardening of arteries everywhere. At the

same time the heart is taxed to send blood through the hardened vessels. The heart enlarges for the purpose. At the same time blood pressure is increased. The relationship is very intricate.

It is not only the parts mentioned that suffer, but the whole of the body. Circulation is impaired, and with it the chemistry of every cell. Sometimes the cells of the brain seem to suffer most.

Premature ageing is thought to be sometimes due to an hereditary tendency. In some families, old age comes on earlier than in others, partly, it is thought, because of the inheritance of poor elastic tissue in arteries. If such inheritance is suspected, disease may often be averted by a little more than usual care.

The avoidance of such a complicated and serious series of disease processes is by adequate rest and sleep, by a life adapted to one's strength, and by regulation of the tense emotions. The avoidance of self-made and external poisons and of any kind of infection is important. Excesses in diet are likely to be habitual in those who develop arterio-sclerosis. They are frequently heavy eaters, often heavy consumers of alcoholic beverages, and usually indulge in dissipation of either work or pleasure, lose sleep and take no exercise.

It is not necessary to look forward to the sequence of events mentioned if the early signs are discovered and the physical defects or the habits of living are corrected. The individual who regulates his life according to hygienic standards need have no fear of trouble of this kind, especially if he has a physical examination and advice occasionally, to make sure that he is using discretion in his health procedures.

The hygiene of the veins, which are more or less passive carriers of blood, unlike the active arteries, is largely that of avoiding conditions that lead to their dilatation. They are emptied freely during exercise unless some constriction prevents. If there is constriction about the body anywhere, the return circulation through the veins is hampered. When veins dilate, they are called varicose. There is some hereditary tendency to the ailment. In such a case, extra precautions should be taken. Varicose veins are most common

in the legs. Garters about the leg are the chief sort of constriction that interferes with circulation.

Occasionally the blood vessels of the anus get pressed on and they dilate, causing the condition known as hemorrhoids or "piles." Often the correction of constipation does away with a tendency to them, and a little local treatment cures those that have already formed.

The term anemia has already been mentioned as the term that describes lack of blood in a part of the body. It is also used in another sense. In fact, the commonest use of the term is as the name of a condition of the blood in which there are either too few red cells, or too little hemoglobin in each cell. In some forms of anemia the blood is lacking in both of these respects. Whichever is the case, the result is that the blood is not able to carry enough oxygen to supply tissue needs.

Anemia is due to a number of causes. First, it may be due to actual loss of blood by hemorrhage, either a large loss at one time or a small loss continued. Excessive or too frequent menstruation may lead to anemia. The minute amount of bleeding over a long period of time from sore gums or from hemorrhoids be sufficient to cause some degree of anemia.

Anemia may also be caused by the destruction of the red blood cells by poisons or by parasites. Anemia is probably more often caused by the parasites of hookworm and of malaria than by any other causes. A similar destruction of red blood corpuscles may be brought about by other parasites—for example by the bacteria that develop in the intestinal tract when chronic constipation exists, or the bacteria that cause most acute or chronic infections—even those found in tooth abscesses or chronic ear infections. Syphilis and tuberculosis cause a persistent anemia that, like all anemia due to bacteria, is incurable while the underlying disease lasts. It is of little use to take iron as long as the bacterial cause of the anemia remains. The same is to some extent true of anemia from any cause. Poisoning by certain metals, especially some that are used in industry (e.g. lead), is a common cause of anemia.

Not infrequently anemia is found to be due, so far as may be determined, solely to certain poor habits of living. The

diet, in particular, has a great deal to do with the number and quality of the red blood cells. A diet that is insufficient in amount, lacks vegetables, and predominates in sweets and starches is very likely to produce anemia. Next in importance to the diet as a cause of anemia is lack of sufficient exercise. Exercise demands more oxygen, and as a result more red cells develop to carry it. The benefits are shared by the tissues all over the body.

Lack of fresh air is particularly likely to lead to anemia. There is a very marked difference between the same individual's percentage of hemoglobin when he is more or less housed in the winter, and when he is living a more outdoor life in the summer. This may be partly due to the effect of summer diet, which is more likely to contain vegetables; and to the effect of sunlight, another important factor in preventing or curing anemia. Spring tonics for the blood would not be necessary if, in winter, air and food and exercise were adequate.

The cure of anemia that is due to inadequate food is often difficult because of a poor appetite. To improve the appetite (and at the same time, the anemia itself) the individual must take outdoor exercise regularly. Often this is just what he does not want to do because he gets tired easily. He is uncomfortable in action, and usually remains quiet, often being called lazy. It is important to prevent or cure anemia, because not only physical but mental vigor depends on the oxygen supply to cells.

Iron is sometimes given to supply the iron that is lacking in the hemoglobin of the red cells. There should always be, at the same time, an effort to increase the amount of iron-bearing foods—vegetables and fruit, meat, milk, eggs and whole wheat.

There is no condition known to science as "bad" blood. When the blood is at fault it is so in certain definite respects. Its red cells may be too few or too low in hemoglobin; its white cells may be too few or not sufficiently active as phagocytes; its plasma may carry toxins and not carry enough anti-bodies against infection. Except for the addition to the plasma of substances to prevent or counteract specific infections, the measures mentioned for the improvement of the red cells

constitute those for the improvement of all of the elements of the blood. As important as the improvement of the elements of the blood itself is the regulation of the activity of the circulation and the maintenance of normal blood pressure, both of which are influenced by the structural soundness of heart and blood vessels and by the daily conduct of life.

R. M.

CHAPTER XXXI

THE HYGIENE OF THE RESPIRATORY SYSTEM

The respiratory tract sometimes requires considerable attention to keep it structurally sound, uninfected and functioning well.

FIG. 217—Diagram illustrating deviation of the nasal septum. (From Coakley "Diseases of the Nose and Throat." Courtesy of Lea and Febinger, Publishers.)

The most fundamental necessity in the breathing apparatus is a clear air-way from the nose through to the lungs. Not infrequently the passage is blocked at some point. The nasal passages may be naturally narrow, but they are also likely to become so from either accident or disease. In either case the formation of the middle partition or septum may be such

that either or both nostrils do not admit air. The turbinate bones may be so enlarged as to encroach upon the air-space in either one or both nostrils. The mucous membranes may be so congested as to diminish the narrow nasal space. The nasopharynx may be blocked by adenoid tissue, or the oropharynx by enlarged tonsils. Sometimes an operation is needed to get a clear air-way through either nose or throat to the lungs.

The enlargement of the soft tissues in the nose and throat may be the accompaniment of an acute inflammation, or it may be chronic. During a cold one usually has some difficulty in breathing through the nose because of the swelling. Often this is the first sign of a cold. When the cold is over, the tissues return to their former size. But repeated colds may leave them somewhat swollen chronically. They are then still more subject to acute infection. The individual who has repeated colds either already has chronic trouble or is tending in that direction.

An acute nasal catarrh (excess of secretion) may be caused by irritating dusts, fumes or vapors; or by wind; or by dry hot air; or by the pollen of certain plants (hay fever); or by certain articles of food against which one has an idiosyncrasy; or by sudden chilling; or, finally, by the local activity of bacteria. Most of these causes affect also the mucous membrane of the eye as well. Sneezing usually accompanies the discharge. If there is much congestion, especially of the mucous membrane in the sinuses, headache is likely to occur. Most of the causes mentioned give only a transitory condition, that stops as soon as the cause is removed. But the last cause, infection, usually goes on to produce a pus secretion following the watery one, especially if nothing is done to stop it in the earlier stage.

Chronic inflammation of the respiratory mucous membranes produces a symptom laymen call catarrh, which means an excess of secretion from some part of the respiratory tract. The term is entirely by descriptive.* It is not the name of a

* The term means literally a "flowing downward." It is applied to other mucous membranes than those of the respiratory tract. The underlying cause is irritation or inflammation of the membrane.

disease, but of a condition, which may be either acute or chronic, and may involve the mucous membranes of the whole respiratory tract or of only one part of it.

Chronic nasal catarrh is sometimes caused by anatomical deformities such as have been mentioned. Occluded nostrils, congestion and infection, possibly of the whole tract may follow such deformities. A nasal catarrh leads often to mouth breathing, and this in trun, if it occurs early in life, to protruding teeth. A chronic catarrhal condition may also result from continued exposure to the same causes as were mentioned in reference to acute catarrh. Much chronic catarrh is due to repeated infections which leave the mucous membrane in an unhealthy condition. Sometimes, after an acute infection, all of the mucous membrane may return to normal except that in the sinuses, in which case there appears, in an apparently normal nose and throat, a discharge of secretion formed in the sinuses. Obstruction to breathing through the nose is a contributory factor in many cases of sinus disease.

The characteristic feature of chronic nasal catarrh is the discharge; but there is also often an unresonant voice, mouth breathing, headache, mental dullness, and poor general health. Although the condition is difficult to cure, in many cases catarrh is benefitted by changes in the habits of living. Aside from correcting any faulty habits of living, no self-treatment should be used (such as douches and sprays, which may make it worse). A nose and throat specialist should be consulted.

An acute catarrhal condition is most commonly found as the prominent symptom in a "cold." Colds are infections of the upper respiratory tract, usually fairly diffuse, but named according to the part involved (rhinitis, inflammation of the nose; laryngitis, inflammation of the larynx; etc.). These infections are due to many sorts of pus-producing bacteria. Whatever the predisposing cause, bacteria are always the immediate cause. The offending bacteria may be those that were already present, but quiescent because conditions were not favorable for their action; or they may be bacteria newly acquired from another person. The prevention of colds involves both the prevention of conditions in

the body that favor the activity of bacteria, and the prevention of exposure to bacteria given off from the respiratory tract of others.

The prevention of the common "cold" needs special discussion, because it is probably the most prevalent, and in the aggregate the most disabling, ailment to which man is subject. Were the end results of colds to be included together with their immediate effects, in computing the disability caused by

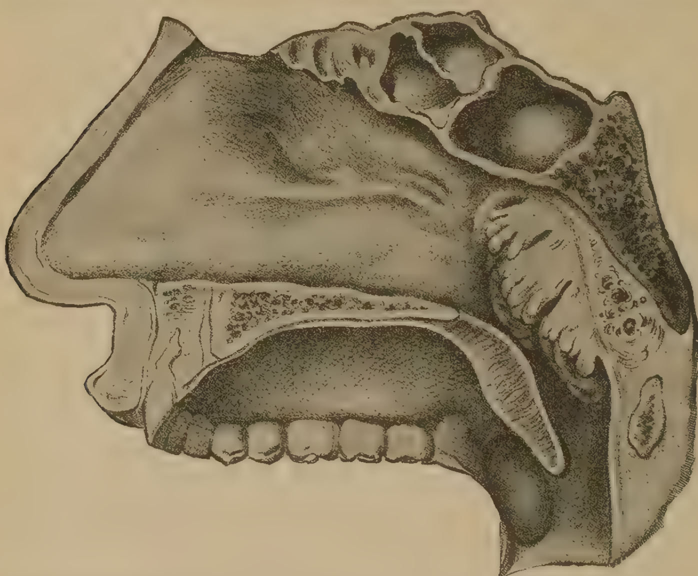


FIG. 218.—Adenoid tissues in the nasopharynx. (From Coakley, "Diseases of the Nose and Throat." Courtesy of Lea and Febinger, Publishers.)

them, the significance of colds would surpass that of any other ailment.

The conditions that favor bacterial activity such as produces colds, are either conditions in the respiratory tract itself, or in other parts of the body. In the respiratory tract increased facilities for bacterial growth may be provided by a mucous membrane of poor character, either naturally so, or acutely irritated or perhaps chronically infected; the presence of adenoids or diseased tonsils; or the presence of obstructions in the nose.

Of the more remote conditions that favor colds, the most prominent is the effect of imperfect temperature regulation. Chilling of the exterior of the body in many individuals results in internal changes that make the mucous membranes susceptible to infection. If the circulation is active, no bad results may follow external chilling; but if the mucous membranes become congested and the congestion continues, and bacteria are present or enter, a cold is likely to follow. The first step in a cold is the oozing out from the congested mucous membrane of a watery fluid. This gives the bacteria an environment in which they grow well. Soon the fluid becomes thicker and yellowish because of the increased growth of pus germs.

The earliest subjective signs of a cold are due to the thickening of the mucous membrane. A feeling of "stuffiness" is often the first sign of all. Perhaps the mucous membrane may feel dry, irritated and "raw," or there may be a tickling sensation. Then one sneezes, the nose begins to "run," and the eyes may "water." All these symptoms are signs of local congestion only, not necessarily of infection. These symptoms may mean that the body has not reacted well to external cold, although they may arise under other circumstances.

The term "catching cold" is often a significant one, indicating that exposure to cold was involved in the process. A draft on the body or any local chilling, as from wet feet, makes temperature regulation more difficult than does the cooling of the whole body. The commonly observable relationship between exposure to cold and "colds" has in the past led individuals to guard too cautiously against such exposure. If local chilling, or prolonged general chilling when inactive, is avoided, one is better off for having considerable practice in adapting to external cold. The toughening process is valuable if undertaken gradually, although one should not carry it to the extreme of going without enough clothing. The undernourished need warning against incautious exposure. The season for colds is largely winter, but for those who know how, the adaptation to winter is no more difficult than the adaptation to summer.

Colds on the whole are more often the result of heat indoors than of cold outdoors. Outdoor workers in the cold, even Arctic explorers, seldom have colds. One may be very cold and yet not chilled. The bad effects of chilling are more prevalent in the tender "hot-house plants."

Not all colds result from congestion that activates bacteria already present. Some are very definitely "caught" from others with colds. When one is exposed to lively bacteria given off from somebody else who has a cold, the infection in one's self may come on without any particular contributing factors such as chilling. One need not be in any way in poor health, even temporarily, to catch cold when sufficiently exposed to active bacteria. Furthermore, it is a mistake to rely too much on a state of general good health to protect one's self from catching colds from infected individuals with whom there is close association.

The means by which bacteria are transferred from one to another are classified as direct and indirect contact. Direct contact includes especially person-to-person transfer as in kissing, or the breathing in of droplets from another individual as they are given off in coughing and sneezing and in talking at short range. It is better to keep a reasonable distance away from those with colds.

The unguarded cough or sneeze is a sanitary crime. Possibly it may in time become a social and legal one, as has promiscuous spitting. In coughing and sneezing there should be no mere perfunctory covering of the mouth with the hand, but a complete and effective covering of both mouth and nose with the handkerchief. If the hand is used for this purpose, moisture with bacteria will be present on it, and may be passed on, by handshaking or by objects touched. The use of gauze or paper handkerchiefs, that may be destroyed, is recommended. Handkerchiefs soiled with secretions may carry bacteria for days.

Inanimate objects handled by those with colds may carry infection if touched immediately afterward by another. The chief danger of this sort is from toilet articles that may be used by others. There are laws against public drinking cups, but it is not uncommon to find a single glass in the bathroom, used

by a whole family. Of course colds "run through families" when direct and indirect contact prevail so generally.

The individual with a cold should learn not to be a menace to others. Ideally, he should be isolated as completely as the individual with measles. Practically, he can and should learn to be among others without scattering his germs, if, in the interest of his own health, it is safe for him to be about. Behavior when among others, while afflicted with a cold, includes efforts to prevent one's bacteria from getting into the surrounding atmosphere, or into the faces of others, or onto their belongings, or onto articles used in common with others. It is not necessary to enumerate the various things one must not do, since the principle will be a sufficient guide, if it is applied at all points.

When obliged to associate closely with an individual who has a cold, one should, but probably will not, feel privileged to remind him of his duty in these respects if he shows signs of forgetting them. If one cannot take the direct method of protecting one's self, the next best method is to keep out of range of the droplets and to avoid touching the other's possibly infected belongings. At the same time extra precautions should be used to keep up general resistance. The importance of keeping one's own probably infected hands out of the nose and mouth needs to be particularly recalled at times when one is associating with the infected.

Aside from body chilling, several other general matters of hygiene should be mentioned in relation to colds. It has been observed that fatigue renders one more susceptible, probably because the acid products of fatigue interfere with the action of the protective substances in the blood. It has also been observed that constipation and certain forms of indigestion render one more susceptible. The slothful also seem to be more addicted to colds, because of their sluggish circulation. Loss of sleep and many other bad habits predispose to disease of all sorts, including colds.

Some individuals have been cured of a tendency to colds by acquiring habits of exercise, others by cold bathing, others by preventing constipation, and others by reducing the temperature of the rooms in which they spend most of their time.

Others have had to have tonsils removed before the tendency to colds has disappeared. The bacteria that live in the tonsils are always ready, if conditions are favorable, to cause colds, or even more serious trouble. Sometimes the tendency to colds may be prevented by vaccines. No two individuals have exactly the same reason for the colds they have, and even in the same individual not all colds seem to be attributable to the same causative factors. There is no single preventive measure and no single curative measure.

It is a mistake to take all sorts of risks and rely on the use of gargles to prevent colds. Prevention is not so simple as that. Gargles may be used on special exposure, and there is no harm in using very mild gargles daily. Their effect, however, is largely that of washing the secretions and bacteria from the mucous membranes, rather than of killing the bacteria *in situ.* A normal mucous membrane is practically self-cleansing, and needs no locally applied treatment as a routine measure of hygiene.

The term "nothing but a cold" is so often heard that the possible outcome of a cold should be emphasized. In the first place, what seems like a cold may be the beginning of measles, German measles, scarlet fever, whooping-cough, diphtheria, influenza, pneumonia, or a number of other diseases. Even a cold one does not wish to pass on to others, but if that which is apparently a cold happens to be one of these other maladies, perhaps the individual with a cold may be spreading much serious illness. All the illnesses mentioned are "catching" at the time when they may seem like an ordinary cold.

Furthermore, it is not only for the protection of others, but to avoid serious illness in one's self that what seems like a cold should have early attention. Even though nothing but a cold develops, that in itself may, if neglected, be followed by complications such as ear, mastoid or sinus disease. Finally, if it merely continues as a simple uncomplicated cold, it may be so prolonged as to cause considerable loss of time and efficiency, while being objectionable to one's self and others.

From all points of view the time to stop a cold is at its beginning. There is no need of having a long cold when one might have a short one. It is not usually a loss of time, even,

to interrupt one's work in order to give proper attention at the start to a beginning cold. It would be theoretically desirable to have medical attention for every cold. Practically, this seems not to be considered feasible. The self-treatment of colds should be very simple, however, and should be discontinued, in favor of more scientific care, if the temperature rises, or the symptoms increase.

About all that one can safely do for one's self when a cold has begun is to get thoroughly warm and go to bed. If the cold is not appreciably better the following morning, it is better to stay in bed until this is the case. Twenty-four hours in bed may save days or even weeks of illness. The reason for going to bed is that the body may be kept warm and given little to do, so that there shall be no strain on temperature regulation and on the system generally. For example, circulation is easier in the horizontal position. The only way to avoid the necessity for remaining in bed is to detect the beginning cold still earlier (i.e. when the body feels chilly or the mucous membrane dry, warm, swollen, raw or tickling), at which time some brisk exercise, avoiding subsequent chilling, may suffice to break up the congestion.

In order to be sure that the body is warm on going to bed, one may take a hot bath, avoiding subsequent exposure, and take hot drinks, such as lemonade. A mild cathartic is desirable also, whether there is apparent necessity for it or not. A considerable amount of water should be taken for many reasons, but especially in order to aid elimination by the kidneys. While staying in bed to aid in curing a cold, one should not eat too heartily, especially of meat, but it is not necessary to deprive one's self of ordinary food to any marked degree. In fact it is better to eat plenty of easily digested food. No medication is absolutely necessary for the cold itself. Sodium bicarbonate (baking soda), half a teaspoonful to a glass of water, may be used as a gargle; and may also be taken as a drink several times a day, to limit the general acidity of the body and thus to aid the body in combatting infection. Drinks made of oranges and lemons have a similar effect in limiting body acidity, even though they are themselves acid as taken. Silvol, or whatever has been recommended by one's

own physician, may be used to drop into the nose. Hot compresses over the bridge of the nose sometimes relieve its congestion. If the throat or chest are at all sore, it is better to have a physician, or if there is severe headache or any pain in the ear or much cough. It there is more than a degree of temperature, or if it remains at even that level, a physician should be called. Of course the appearance of any rash or gland swellings should have immediate attention. Aspirin for the relief of pain is not particularly injurious, although it is likely to cause the temperature to fall, and may thus make one think the cold is less severe than it really is. If this supposition led to going back to work too soon, the results might be serious.

When medical advice is readily available there is no excuse for not getting it. Physicians never consider a cold too trivial to be taken seriously, and are often able to increase comfort and hasten recovery. The difference in the duration of colds among those who have been treated promptly and among those who allow a cold to run its course is very marked. Three days is the estimated average duration of colds treated at the Smith College Infirmary. Two weeks is the estimated average in a certain group of equal size of industrial women workers.

Some attention to hygiene is needed on recovery from a cold. One may still be harboring bacteria no longer injurious to one's self but possibly injurious to others. Hence care should be used not to distribute them. One should also guard against overexertion, late hours and chilling. Those who are ordinarily quite hardy are more susceptible to chilling after a cold. A relapse is usually more severe than the original illness.

The tonsils are a frequent source of colds and also of systemic infection involving especially the heart and the joints (rheumatic fever). If tonsils are large they may not be infected, but may be so great an obstruction in the throat that their removal is necessary. If they are chronically infected, they should almost always be removed, even though they are so small as to be hardly visible. No amount of local treatment is likely to change them enough to take them out of the class of the serious menaces to health.

The lungs are subject to the disease tuberculosis, the prevention and cure of which is almost entirely a matter of hygiene. By suitable food, adequate fresh air, and the correct proportions of rest and exercise this serious disease may be avoided. Most adults have had some degree of infection, which, however, will never trouble them unless by unwise living they reduce their general resistance too far. One of the

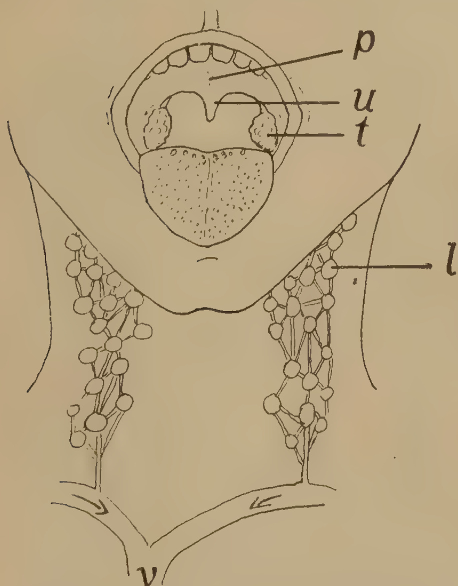


Fig. 219.—The tonsils and the lymphatics associated with them; to show the route of absorption into the circulation of infective material or bacterial toxins. *p*, palate; *u*, uvula; *t*, tonsil; *l*, lymphatics; *v*. vein.

Fig. 220.—Cross section of the tonsil, showing crypts containing exudate.

great dangers of dieting and late hours is the increased susceptibility to tuberculosis. If it is acquired, it is curable by the belated attention to the hygiene measures mentioned. Those who in early adult years still show signs in the chest of a previous, perhaps unsuspected, infection, need especially to avoid physical overstrain and otherwise to observe the practice of hygiene very carefully, in order to avoid re-activation of the infection

The hygiene of the respiratory tract involves some attention to proper methods of breathing. The nose rather than the mouth should be used, and the lower chest rather than the upper. When breathing is done through the mouth, infection of the throat is more likely because the bacteria are not prevented, by the cilia in the nose, from entering the throat, and the air is not properly warmed and moistened there. If

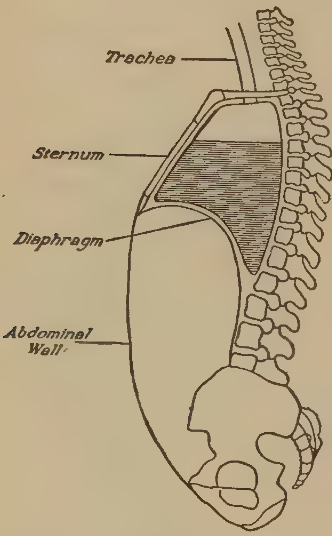


FIG. 221.—Inspiration. (From Williams, "Healthful Living." By permission of The Macmillan Company, Publishers.)

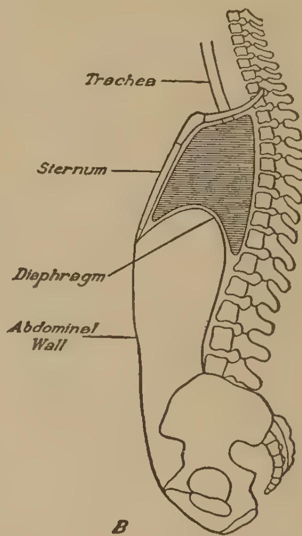


FIG. 222.—Expiration. (From Williams, "Healthful Living." By permission of The Macmillan Company, Publishers.)

there is any defect in nasal breathing, it should be promptly attended to.

One of the chief reasons for breathing with the lower chest is that it gives the diaphragm more activity, which in turn greatly helps circulation. If the lower chest does not expand fully in breathing, exercises should be done until this motion is habitual. Deep-breathing exercises in themselves have no effect in increasing the oxygen in the body. Only general exercise does this. But it does increase the power of the chest muscles, and if conducted properly (i.e., the lower chest

moved) is of value to the circulation. Although vital capacity is measured by the amount of air expelled from the lungs at a single respiration, it is not certain that this alone has any particular significance. Habitual deep breathing, with considerable expansion of the lower chest, seems to indicate fuller vitality, however. A chest that is contracted, barely moving at each respiration, is often found in tense, delicate individuals who are nervously and physically below par; whereas good vital capacity seems usually to accompany good health and a good physique.

The hygiene of the respiratory system also includes the hygiene of the voice, which depends on the use of the lungs to supply the volume of air that comes up through the larynx. A good voice entails a good air supply, and this entails good postuer and the proper method of breathing, with trained control of the muscles used in breathing. The voice also depends on the condition of the larynx and the correct use of its muscles, which depends a good deal on an uncramped position of the neck. Voice production is aided by the presence of a wide passage through the pharynx, especially by freedom from obstruction by enlarged tonsils. The resonance chambers of the upper pharynx should be free from adenoids; those of the nose, free from obstructions and congestion; and those of the sinuses, free from infection. The correct use of the articulating apparatus—lips, tongue and teeth—depends somewhat on the proper shape of the mouth, which is likely not to be satisfactory in mouth breathers, especially those who have protruding teeth. The production of a good voice is a matter of practice only, providing the whole apparatus is such as to make a good voice possible. The voice should not be used when the vocal cords are thickened during a cold involving the larynx, or the cords may be further affected, and the voice be permanently injured.

CHAPTER XXXII

FOOD AND DIET

Man, through the centuries, has managed to be nourished without knowing much about the material that nourished him, or about his own needs for nourishment. He will continue to be so nourished, more or less fully, largely because of the relative validity of appetite. Appetite is not sufficiently valid, however, to be relied on implicitly when knowledge regarding nutrition and nutritive materials may be obtained. Until comparatively recently man was in scarcely better position in respect to the choice of food and the supplying of nutritive needs than are the animals, which are dependent on the sense of taste and the hunger instinct. The best results are obtainable in the case of man's nutrition, when the body's needs are understood, as well as the methods for meeting these needs. Even though it is the business of somebody else to know about these matters, and to see that one is supplied with nourishment, the individual should not feel that he needs no knowledge regarding foods, since he may still go far astray in his choice of food from the variety offered. Moreover, an individual seldom confines his eating to the meals set before him, perhaps by experts. He is likely, at least occasionally, to choose meals for himself. So long as one uses any volition about the choice of food, one must know, in the main, what to choose, or run the risk of being either positively injured by the choice, or, at best, thereby kept below par.

The science of nutrition is a relatively new one, and its development has been coincident with the recent increase in the average length of life. It is thought that there has been some relationship between the development of better dietary habits and longer life. In the case of infants, it is known that better feeding has been the greatest factor in reducing the previously very high rate of infant mortality. During the

past fifty years many investigators of our own and other countries have added so much to the knowledge of nutritional needs that it is now possible to regulate diet in sickness and in health with considerable scientific precision.

In studying the diet of various peoples, it is notable that they resemble each other in one respect at least—that they

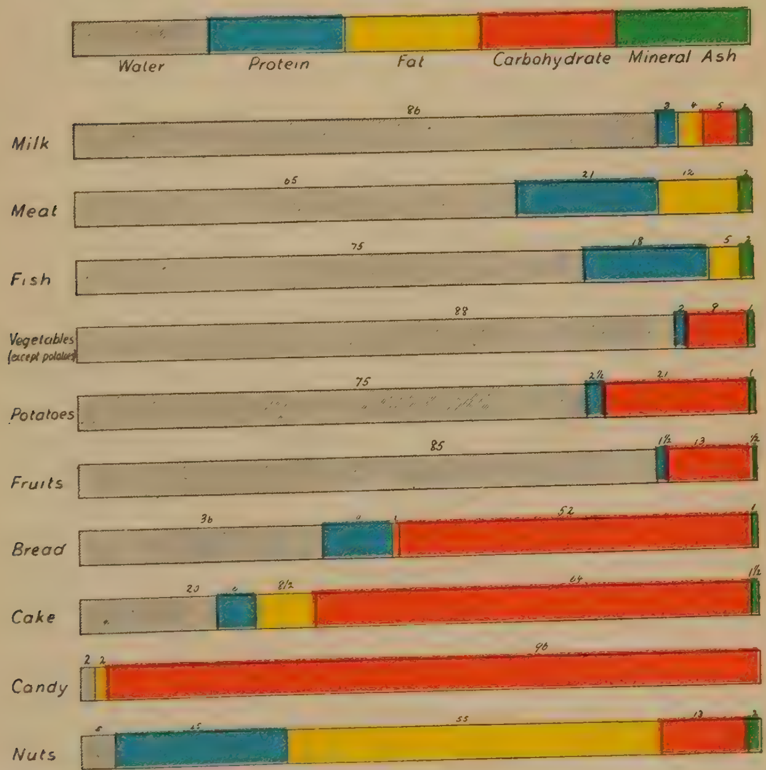


FIG. 223.—Diagram showing the average percentage composition of certain typical foods.

comprise foods that furnish about the same number of calories, regardless of race or climate, and regardless of the substances used as foods.

It is also notable that all races use the same three main food elements, protein, fat and carbohydrate. The proportions of

these, however, vary widely, according to climate, characteristics of the race, prevailing occupation, and available foods.

Whether race characteristics determine food eaten, or whether food eaten determines race characteristics, can hardly be discussed here. Yet it is rather evident that the more energetic, active and progressive races usually eat more protein, and the more lethargic ones less.

On the whole, adequacy of diet in respect to amount of food and in respect to the food stuffs used, seems to have a determining effect on the supremacy of races. The underfed race, like the underfed individual, does not stand out brilliantly in history. In fact, failure to survive marks such a race, unless the gross increase in population is enormous.

The essentials of diet may be considered to be, first, a sufficient quantity; second, sufficient of each of the various necessary food elements.

The uses of food in the body have already been discussed. Briefly, we eat in order to supply materials for body growth and maintenance of tissues, and to supply material for the production of heat and energy. The dividing line between the foods that do the one thing and those that do the other is not so marked as is sometimes thought. For example, a man who wished to have a great deal of energy would not be justified, after finding out what the so-called "energy-producing" foods are, in eating a great deal of them exclusively. He would be wiser if he made an effort to satisfy nutritive demands in a general way, thus making each cell as normal as possible, expecting his possession of energy to be in accord with his good condition. It is true, as is sometimes mentioned, that sugar gives immediate possibility of more energy use. But for dietary purposes and for health reasons, the use of sugar on such occasions as demand energy is usually inappropriate.

Food is eaten not because there is necessarily observed at the moment a need either for energy or for tissue repair. It is to be eaten regularly, regardless of apparent special need, in order that one may be prepared both for regular and special needs as they arise. An excess of food is usually eaten, beyond the needs of the moment, that which is not utilized being given off or stored. The possibility of storage is one of the greatest

factors of safety. If for a time one cannot get food, or cannot, or perhaps should not, eat (as in times when digestive disturbances or emotional unrest interferes), the body goes on well, if previously enough food has been eaten to equip the storage places. If one habitually eats so little that little is stored, the body suffers unnecessarily in times of emergency. Yet it is not desirable to try to store too much, so that weight is unduly increased. This is, in its way, as harmful as too little storage.

The quantity of food to be eaten is to be gauged by the number of calories it affords. The calorie is a unit of heat production, being the amount of heat needed to raise one kilogram of water one degree centigrade, or approximately one pound of water four degrees Fahrenheit. The heat-producing power of any combustible substance may be determined outside the body; and by tests carried on in laboratories on human beings, its physiological caloric value may be determined. Since heat and energy are synonymous terms, every article of food has a certain heat or energy value, which is computed in calories. The diet must provide a sufficient number of calories to maintain body temperature and support body functions while at rest, and an additional number in proportion to the activity engaged in, and to compensate for the effect of environmental cold.

The food eaten furnishes not merely the material for the production of energy and heat, but also furnishes material for growth and repair. The amount of food is not to be chosen, then, solely on a caloric basis, but with the other needs of the body in mind. If 2500 calories per day are necessary for an adult at a more or less sedentary occupation, it may be estimated that the food capable of furnishing this number of calories will, if well chosen and fully absorbed, supply at the same time enough material for growth and rebuilding.

There has been too much attention given recently to the regulation of diet by calories, and not enough to the proportions of food elements that supply them. It is not suitable to choose a diet entirely according to calories. Yet an individual cannot, even on a well-chosen diet—one that supplies all the necessary nutrient materials—restrict his calories to too low a level, without danger of general loss of vitality. Twenty-five

hundred calories a day is about the correct amount for a sedentary individual getting one hour's exercise a day.

The physiological fuel value of protein and carbohydrates is about the same, whereas the caloric value of fats is about twice as much per unit of weight. Certain foods have the same caloric value and very different nutritive value. Man cannot live, for example, on the carbohydrates and fats alone. Moreover, foods must be chosen not only for their caloric value and for their cell maintenance value, but also from the practical point of view of their suitability in respect to bulk. Of some foods the amount that would have to be eaten to get a sufficient number of calories and sufficient building material would be enormous. It would be necessary, for example, to eat thirty-five pounds of lettuce to get a day's caloric needs, or one and a half pounds of cheese, or thirty-eight eggs, or thirteen pounds of oysters. Such amounts of single articles of food would also fail to supply the proper proportions of food elements, although supplying enough calories. It will be readily seen that consideration of caloric value alone is not practical, either from the point of view of bulk, or from the point of view of meeting special nutritional needs. Although it is important to be familiar with caloric values, this is only the first step in understanding nutritional needs.

Foods as eaten consist of substances that are nutritive and of other substances that are non-nutritive. Nutritive food substances may be defined as those that after absorption build up tissue or yield heat and energy. They include the three main food stuffs, protein, fat and carbohydrate. There are other nutritive substances, however, which are prime essentials to life, since they take part in the chemical activities of the body and permit the body to be nourished and thus to be able to exhibit energy. Among these are chiefly water, the mineral salts, and the vitamins. Six substances, rather than the three commonly spoken of as nutritive substances, are actually required in order to maintain adequate nutrition. Material in the food that is entirely waste (non-nutritive) is also desirable, in that it enables the intestinal tract to have the advantage provided by bulk. A diet lacking in bulk moves slowly through the intestines and is seldom so well dealt with

by the intestine as a diet that contains a considerable amount of waste material—chiefly the cellulose of vegetables and grains and fruits. Whatever foods are chosen, some of them must afford sufficient bulk, which is necessary to aid in the progress of food through the digestive tract, and in the elimination of waste.

Protein contains carbon, hydrogen, oxygen and nitrogen. It is the only food that contains nitrogen, hence the only food that can supply whatever of nitrogen is lost from the protoplasm of cells in their daily wear and tear. The chief sources of protein in the diet are meat, fish, milk and milk products, eggs, nuts, and to some extent vegetables and the seeds of grains, such as are used as cereals and for the making of bread.

In the temperate climate the sedentary worker usually takes from seventy-five to one hundred grams of protein a day, and does not greatly increase this amount even when the total food intake is increased. This amount is equivalent to about one ordinary portion of meat once a day, plus the incidental protein taken in a mixed diet. There are races, such as the Eskimos, that eat much more protein, apparently without harm. Certain animals, the carnivorous, not only take large amounts of protein food, but take it entirely in the form of animal protein. Other animals are herbiverous, obtaining their protein only from the vegetable kingdom. Man is omniverous, in the sense that he eats any kind of food, regardless of its vegetable or animal origin. Man's diet normally never includes only protein, although he could live on protein, salts and water—with some physiological difficulty—since protein may be converted into carbohydrate from which energy is available.

The source of protein for man has been much discussed. It may be from either animal or vegetable sources, but the preponderance of opinion favors the inclusion of some animal protein in the diet, including that form which is found in meat and fish. Vegetarians are of two sorts, those who get their protein entirely from the vegetable kingdom (vegetables such as beans and peas, and nuts); and those who include animal protein, such as milk, cheese and eggs, but exclude meat. The latter, of course, are not true vegetarians.

Ordinarily the sedentary worker takes five per cent of his calories in the form of meat and other animal protein, and another five per cent from vegetable sources of protein.

The choice of protein is to be made according to the number, kind and amount of available amino-acids they contain. Some amino-acids, but not all, can be used by the body to build up its own protein. No one protein contains the exact proportionate amounts needed by all the cells of the body. Some lack certain essential amino-acids. Gelatin, for example, has a very high percentage of protein, yet it

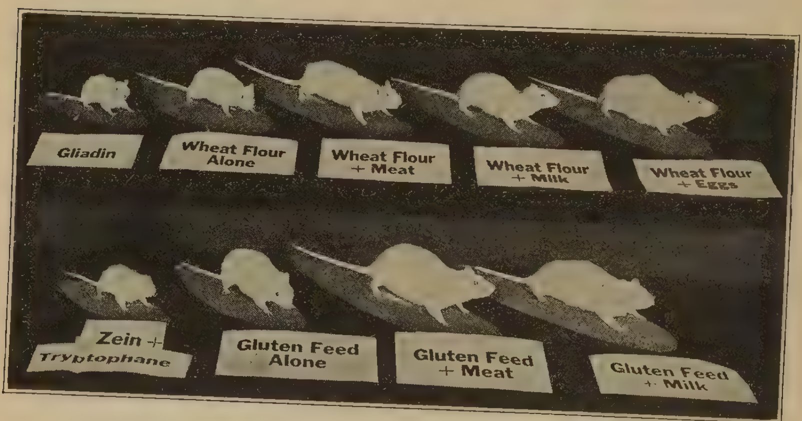


Fig. 224.—Illustrating the variation in the nutrition of rats according to the variation in the kind of proteins in the diet. (From Mendel, "Nutrition." Courtesy of the Yale University Press.)

lacks three essential amino-acids. Beans, bread and cereals contain many amino-acids, but it would be necessary to take larger quantities of protein in this form in order to supply body demands for particular amino-acids. The most physiologically economical sources of protein are the animal ones, such as meat. They supply more of the amino-acids the body needs, and fewer of those that are of no use and must be excreted. The potato, that is usually eaten with meat, also contains in its protein all the necessary amino-acids. It is desirable that a variety of proteins be included in the diet, in order to make certain that a minimum supply is available of all the necessary amino-acids.

Milk is in many ways an ideal source of protein. It is urged upon families with small incomes that they consider a sufficient supply of milk as more necessary than any other food, chiefly because it is an easily available protein, but also because it contains other growth-favoring substances especially needed by the young. Eggs have a higher standing than they deserve, in that it takes more eggs than are usually eaten to give the day's ration of protein. Cheese and peas and beans, although high in protein, are not as satisfactory as meat for the main source of protein, since they place greater demands on the digestion, although for variety they are most satisfactory.

Meat has usually been considered the foundation of the diet. It is a mistake, however, to consider meat the only "nourishing" food and to feel that one has eaten nothing if a meal does not include meat. It is possible to take enough protein on a meat-free diet. Furthermore, carbohydrate and fat and the accessory foods are of as much importance in nutrition as is meat.

Meat is from 50 per cent to 90 per cent protein, the rest being largely fat and fibrous tissue. It is the easiest and most palatable source of nitrogen. Fish is very similar to meat, except that it contains less protein (6 to 25 per cent), the rest being fat and water. It is an equally good but diluted source of protein, and as easily digested, except when the percentage of fat is very high, as in salmon. Fish does not have a special effect in nourishing the brain, as is sometimes claimed. Since fish is easily digested, it reduces the blood supply in the brain for a shorter period than do some meats, and in this way its ingestion in preference to meat might favor cerebral activity.

There is very little difference between red and white meat. The former contains more extractives, substances that give flavor and make them more appetizing to many, and is often thus better digested. Extractives sometimes cause difficulty if taken to excess, because one of their end-products is uric acid, which must be excreted by the kidney. Because extractives stimulate appetite they are a desirable aid to gastric secretion, but they may cause an individual to eat more meat than is good for him.

Soup made of meat may be made so as to contain a considerable amount of nourishment in the form of protein, or it may be made so that it contains chiefly the extractives or flavoring matter, which have no nutritive value—as in bouillon, which should be used only as an appetizer and as an aid to digestion. If taken alone, it causes the digestive system to be ready for food, without supplying the food, thus doing more harm than good. Animals fed on beef extract die sooner than those not fed at all. Bouillon or broth should always be followed by food. If no food is to follow, and one wishes it for its warmth or pleasant flavor, crackers should be taken with it, or, better still, substances that are more nutritive be taken instead.

It ordinarily makes little difference which sort of meat is eaten. If meat is well cooked, it should always be easy of digestion by a normal digestive tract. Pork and ham digest as well, but require more prolonged action of the digestive tract, and are therefore not so desirable as other meats for the sedentary or those with feeble digestive power. Whereas in Germany veal is considered easy of digestion and beef not, in this country the reverse is generally held to be true. There is probably little difference between them in this respect.

Meat protein in particular has the effect of raising the rate of metabolism, and of heat production. It tends to cause the body to be warmer, both in winter and in summer. One would, then, eat somewhat less meat in summer, and also in time of fever when the body temperature is already high, and would take the full amount in winter. As has been stated in a previous chapter, the non-nitrogenous part of protein is utilised by the body for fuel.

There is some discussion about the desirability of diets containing much protein, and of those containing little protein, with ardent proponents of each theory. Some investigators think man never gets too much, and others that man usually gets too much. Those who hold the latter theory attribute some of the degenerative diseases to the overeating of protein. An eminent authority has suggested sixty grams instead of seventy-five or a hundred grams a day. Others, however, believe that on a diet low in protein there is lessened resistance and recuperative power, a tendency to anemia, sensitiveness

to cold, and a generally less satisfactory state of health. In the Orient, where little protein is taken, there is found quite generally a poor type of muscle development.

Men of great strength vary in the amount of protein they eat. Sandow is said to have taken 240 grams daily, instead of the customary 75–100 grams. It is certain that if larger quantities of protein are taken, elimination must be good by means of the kidney and also the intestine. Muscle workers can usually utilize more protein than can the sedentary, without taxing the system. Perhaps a normal excretory apparatus need never be considered from the point of view of damaging it by excess of protein, providing the individual is sufficiently active, although impaired kidneys are usually to be somewhat protected in this respect. An individual should not attempt to reduce his protein below the usual amount except under medical supervision. In the absence of medical advice to the contrary, the amount of protein to be taken daily may be estimated as a little more than half a gram per pound of body weight, which is slightly less than is at present customary, and slightly less than was formerly recommended.

Fat and carbohydrates are unlike protein in that neither of them alone, nor both, would maintain life. This is because they contain only carbon, hydrogen and oxygen, and do not contain nitrogen. They contain chiefly fuel substances, whereas protein contains both fuel substances and the material for structural upbuilding.

Fats are usually to be taken to the extent of about one hundred grams a day. They form a more concentrated fuel than the carbohydrates, in that they can take up more oxygen since they contain less at the start. They are, however, harder to burn up completely in the body. Hence they do not actually furnish a proportionate amount of heat or energy. In increasing the total amount of food, the increase will usually not be much greater in respect to fats than in respect to protein. Fats are found in butter, cream, oil, cheese, yolks of eggs, olives, nuts, the fat of meat, and the fats and oils used in cooking.

The natural fats are quite easily assimilated. The same is not true of combined or cooked fats. It is the combination of

fat and protein that makes pork harder to digest. It is because of the cooking of the fats at high temperatures that fried foods are hard to digest. Pastry and rich cakes are rather indigestible because the fat globules are surrounded by other substances in the food, so that the digestive juices cannot easily reach them. Furthermore, the excess of fatty acids may be irritating to the digestive tract. Fat is not appetizing nor assimilable in unlimited amounts. In excess it becomes offensive to the appetite and is refused. If not refused, the diges-

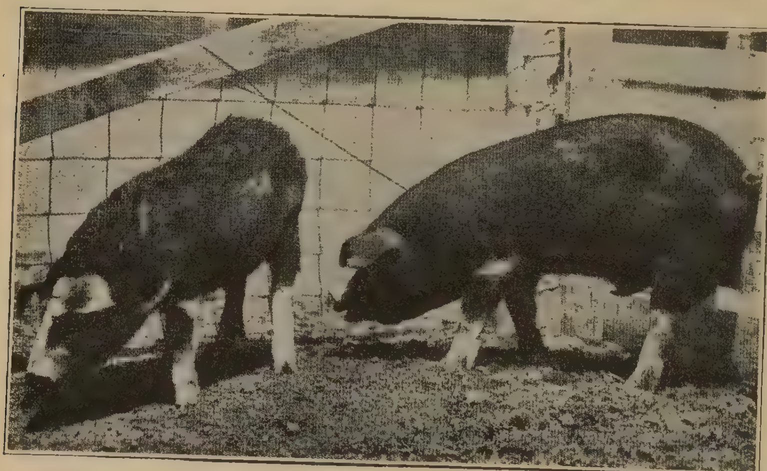


FIG. 225.—Illustrating the improved nutrition of pigs when the sole difference in diet was the addition of butter fat. (From Mendel, "Nutrition." Courtesy of the Yale University Press.)

tion usually balks at it. A feeble digestion sometimes balks at any fat in an undisguised form, such as cream.

In the ordinary dietary there is seldom too little fat. It should not be voluntarily too greatly limited because it is an easy source of energy. Possibly it also takes part in the repair of certain structures in the body that contain fat. If too little fat is taken constipation may result. If too much is taken, indigestion may result, especially a form known as acidosis, which results when much fat and little carbohydrate is taken. It is often erroneously supposed that obesity results from over-

consumption of fat. While it is true that an excess of fat may be stored as adipose tissue, this result occurs much more often from excess of carbohydrates.

The carbohydrate need of the body is about 300 grams a day for the individual using twenty-five hundred calories. This is the most elastic part of the dietary. Greater energy needs of the body may be most easily met by an increase in carbohydrates. If reduction of the total food intake is necessary, it may best be accomplished by limiting the carbohydrates.

The carbohydrate foods are classified as starches and sugars. The starches are usually found in connection with other of the food elements. In grains, potatoes, peas and beans, they are found with protein. Carbohydrate in the form of starch is also found in other vegetables in varying proportions. The sugars are found in the pure form in cane sugar and honey. There is also a high percentage in the sweet fruits, in beets, and in milk, as lactose or milk sugar. Cellulose in vegetables is a variety of carbohydrate which some animals, but not man, can digest. In man's diet it is merely waste.

The excessive eating of concentrated sweets is irritating to the digestive tract. It may lead to acid formation by the process of fermentation, and may give the various symptoms of stomach indigestion. If it is eaten between meals, even if it does not cause indigestion, it is likely to take away the appetite for the regular meals, while in itself not sufficiently supplying nutritional needs. The only proper time to eat candy and foods of high sugar content is after a meal, at which time they are not likely to be taken to excess.

Sugars and starches are not tolerated well in certain diseases, as diabetes. The question has not yet been finally answered whether excessive use of sweets actually leads to the disease, or whether the diabetic's craving for them is only a symptom of the disease.

The excess of carbohydrate being stored as fat, the diet should be restricted, in the obese, in respect to carbohydrate as well as in respect to total quantity of food. It is futile, however, to omit bread and potatoes at the table and to take much sugar- and fat-containing foods in the form of ice cream and cakes and candy, between meals.

Of the total amount of food consumed in the United States it has been estimated that wheat supplies more than 25 per cent of the calories, dairy products 15 per cent, sugars 13 per cent, oils and fats 4 per cent, potatoes 3 per cent, poultry and eggs 2 per cent. Of the meats, pork stands highest, supplying 16 per cent, and beef next, supplying 5 per cent. Next to wheat among the grains, stands corn, which supplies 7 per cent. These percentages are not of amounts eaten, but of calories provided from these foods.

As has been already mentioned, nutrition is not in proportion to the number of calories, regardless of the foods supplying them, but is in proportion to the consumption and body utilisation of a sufficient amount of all the nutritive substances. Because of the many needs for food in the body, it is vastly preferable to eat as most people do, a reasonable amount of all sorts of food. If this is done, one may have little fear of malnutrition or of indigestion. If no other principle of eating than this is followed, an individual will do well. On a mixed diet all of the digestive juices are called into use, and the cells that produce them are kept active. There is little fear of unknowingly depriving the system of important substances, as may be the case in a "faddy" diet. It is not necessary, it should be noted, that each meal in itself contain full proportions of all of the necessary substances, although this is desirable if convenient.

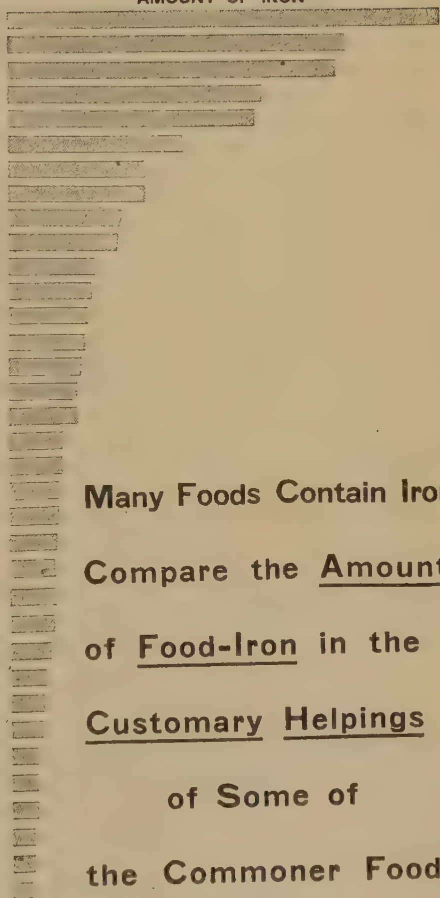
Minerals constitute an important element in the diet since they are essential to proper nutrition. They are not measured by calories, because they furnish no heat or energy; yet they are necessary to life. They are found in most protein-containing foods in varying proportions. In a mixed diet enough mineral ash will be present so that no thought need be given to the matter. Practically the only mineral not present in sufficient amounts in a mixed diet is the one commonly added to give palatability to food, sodium chloride. Those that are needed besides sodium chloride are the salts of potassium, sulphur, iron, and phosphorus, calcium and magnesium. (See Figs. 226, 227.)

Minerals are used to maintain the normal structure of cells and to aid their normal functioning. Some cells use more of one

mineral then another (e.g. red blood cells especially need iron, gastric gland cells need sodium chloride to make hydrochloric

FOOD-IRON

FOOD	HELPING	AMOUNT OF IRON
Beef (Lean)	4 oz.	(570)
Oysters	½ doz. (3½ oz.)	(445)
Spinach	4 oz.	(432)
Liver	4 oz.	(336)
Molasses	1½ oz.	(328)
Wheat Bran	½ oz.	(230)
Egg	2 oz.	(180)
Bread, Boston Brown	2 oz.	(180)
Bread, Graham	2 oz.	(150)
Strawberries	6 oz.	(144)
Potatoes	3 oz.	(117)
Oatmeal	1 oz.	(114)
Peas, Green	2 oz.	(102)
Fish	4 oz.	(101)
Bread, Whole Wheat	2 oz.	(96)
Prunes	1 oz.	(90)
Dates	1 oz.	(90)
Onions	4 oz.	(72)
Banana	1 (4 oz.)	(72)
Cabbage, Raw	2 oz.	(66)
String Beans	2 oz.	(66)
Raisins	1 oz.	(63)
Pineapple	4 oz.	(60)
Milk, Whole	½ pint	(60)
Almonds	½ oz.	(59)
Bread, White	2 oz.	(54)
Tomatoes	1 (4 oz.)	(48)
Sweet Potatoes	3 oz.	(45)
Lettuce	2 oz.	(42)
Beets	2 oz.	(36)
Carrots	2 oz.	(36)
Apple (Fresh)	1 (4 oz.)	(36)
Peanuts	½ oz.	(30)
Turnips	2 oz.	(30)
Cornmeal	1 oz.	(27)



Many Foods Contain Iron.

Compare the Amounts of Food-Iron in the Customary Helpings of Some of the Commoner Foods.

FIG. 226.—(Used by permission of the American Medical Association.)

acid). Calcium salts are especially used in building and repairing bone and in maintaining tooth structure. Iron need

not be especially planned for, since enough is usually provided in a mixed diet. Meat, egg yolk, spinach and most green

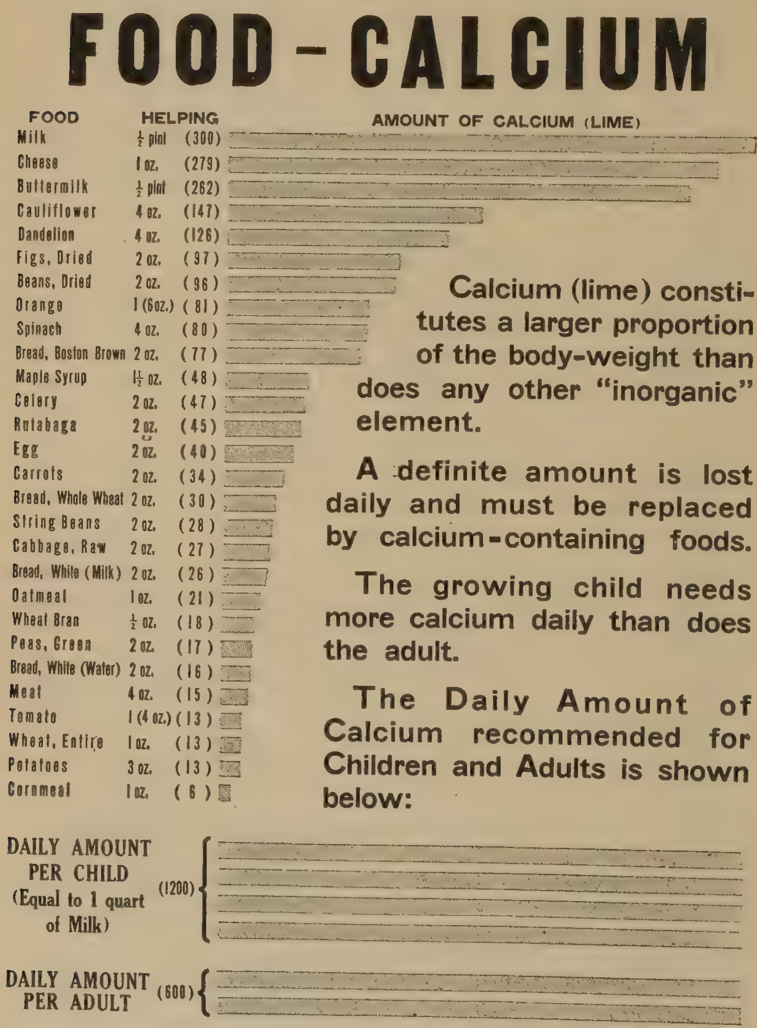


Fig. 227.—(Used by permission of the American Medical Association.)

vegetables, and most fruits contain it. If a generous, well-assorted diet is not provided for adults, they may suffer a

considerable impairment of health, not only from a total reduced food intake, but from the reduced supply of minerals. In the growing period, however, minerals are of the utmost importance. Milk, the chief food of the infant, supplies its mineral needs.

Vitamins are also essential in the diet. This name was applied in 1912 to certain substances in food, whose nature was not determined, yet whose absence had for many years been observed to lead to impaired health. The nature of these substances is not yet fully understood, and it is chiefly by inference that their presence is demonstrated. It can be observed, from the effect on nutrition of the absence of certain foods, that these foods apparently contain substances that others do not, and that the substances missing are such as are essential to nutrition in general and to particular aspects of nutrition. It is the presence of these unknown substances in foods that enables the body to utilise the food containing them, as well as other foods, for its nourishment, although the vitamins themselves have no direct energy-producing value, and do not themselves add to the body's substance.

The existence of substances now called vitamins was first suspected in connection with a disease of the nerves called beri-beri, prevailing, until its cause was understood, in the Orient. The diet of those who had beri-beri consisted chiefly of polished rice. Examination failed to detect any quality in this kind of rice that would cause it to be inferior to other rice as a food, for it is merely rice with the outer covering removed. The conclusion naturally was reached that the outer covering of the rice contained something of value in diet, if those who ate it did not acquire beri-beri, and those who did not eat it did suffer from this disease. Furthermore, it was found that it was only those whose diet contained little else than polished rice who were afflicted. Those who only ate small amounts of such rice occasionally, as in the Occident, did not suffer from it. The conclusion reached was that beri-beri represented a deficiency in the diet of a substance which was obviously present in unpolished rice and not present in the polished variety. Because the substance could not

be described according to its chemical nature (which has apparently been discovered recently), but was presumed to be an amine, and one necessary to life, it was called vitamine. Since later it was questioned whether the substance, and others similar to it in action, were amines, the spelling was changed to vitamin.

Fig. 228.—Rat (No. 4) fed a diet deficient in water-soluble "B." Compare Fig 229. (Hawk, Smith, and Bergeim: American Journal of Physiology, 56, 33, 1921.)

Thereafter the vitamin was found to be present in the outer covering of other grains than rice, as for example, wheat. This vitamin now is known as water-soluble vitamin-B. It has been found to be not only specifically associated with the prevention of the disease beri-beri, but to have important

functions in relation to growth and nutrition. Because it is contained in many sorts of food, a person on a mixed diet will not lack it. It is present in most fruit and vegetables, and in milk. Although it is affected by heat, it is not necessary to eat all fruit, vegetables and milk raw, in order to get

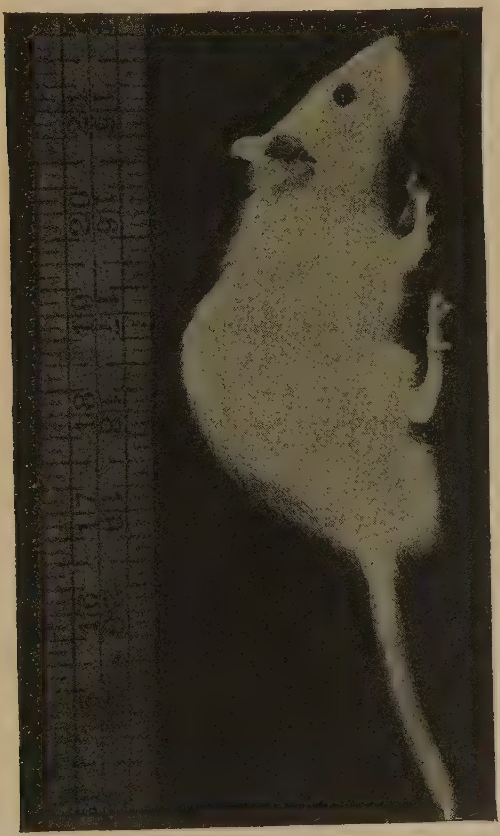


Fig. 229.—Rat (No. 14) fed a diet containing sufficient water-soluble "B." Compare Fig. 228. (Hawk, Smith, and Bergeim: American Journal of Physiology, 56, 33, 1921.)

plenty, for only a small amount is needed. A certain amount of uncooked fruit and vegetables should be eaten, however, and whole wheat bread may be used to advantage at times instead of the usual white bread, although the latter contains the vitamin.

At about the same time another vitamin, fat-soluble vitamin-A, was discovered to exist in the natural fats from animal sources, such as butter, milk, cream, eggs, and cod liver oil. It is also present in leafy vegetables and tomatoes. If a young animal's diet lacks it, the animal ceases to grow at the usual rate; if an older animal's diet lacks it, nutrition suffers. Epithelial tissue is particularly likely to be involved. A serious eye disease is commonly associated with its lack. In children the lack of food such as contains this vitamin is associated with a disease known as rickets, in which the bones are conspicuously malformed, and many other symptoms occur. It is probably not this vitamin in the food, however, which prevents rickets, but a more recently discovered one (D), which is present in many of the same foods.

Fig. 230.—Rat fed a diet deficient in fat-soluble A (left) and rat fed an adequate diet (right). (From McCollum, "The Newer Knowledge of Nutrition." By permission of The Macmillan Company, Publishers.)

A third vitamin, water-soluble C, is found in largest amounts in fresh vegetables and citrous fruits (oranges and lemons). It is also found in tomatoes, even in canned ones, and in potatoes, cabbage, and turnips, and many other fruits and vegetables. The absence of it in the diet is likely to affect especially the connective tissues. Its lack contributes to produce a disease, scurvy, formerly very common among those at sea. The disease also occurs among others on diets limited in respect to fresh food. There is a form of it which occurs in infants. At least two other vitamins

have been identified, one of which (D) appears to be present in some of the foods containing fat-soluble A. It is thought that this vitamin is the one that prevents rickets in children.

VITAMINS IN FOODS

	"A"	"B"	"C"	"D"
BREAD, (WATER)	−	+	−	−
" , (MILK)	+	+	−	+
" , WHOLE WHEAT (WATER)	+	++	−	−
" , " " (MILK)	++	++	?	+
BARLEY (WHOLE)	+	++	−	
CORN, YELLOW	+	++	−	
OATS	+	++	−	−
RYE, CRACKED	+	++	?	
WHEAT, KERNEL	++	+++	−	+
" , BRAN	+	+++	−	
LIVER	++	++	?	+
KIDNEY	++	++	+	+
BRAINS	+	++	?	+
HEART	+	+	+	+
FISH, FAT	+	+	?	−
" , ROE	+	++	?	+
MILK, FRESH, (UNPASTEURIZED)	+++	++	++V	++
" , CONDENSED	+++	++	+V	+
" , EVAPORATED	+++	++	?	
" , DRIED, (WHOLE)	+++	++	+V	
" , SKIMMED	+	+	+V	
BUTTERMILK	+	++	+V	
CREAM	+++	++	+V	
BUTTER	+++	−	−	+
CHEESE	++	++	−	
EGGS	+++	+	−	+
ALMONDS	+	++?	*	
COCONUT	+	++	−	+
HICKORY NUTS	*	++	*	
PEANUTS	+	++	*	
WALNUTS	*	++	*	

	"A"	"B"	"C"	"D"
TOMATO (RAW OR CANNED)	++	+++	+++	
BEANS, KIDNEY	+	+++	*	
" , NAVY	+	+++	*	
" , STRING	++	++	+	
BEETS	−	+	+	
CABBAGE, RAW	++	+++	+++	
" , CANNED	*	*	++	
" , COOKED BRIEFLY	++	++	+	
CARROT, RAW	++	+	+	
" , COOKED	++	+	+V	
CAULIFLOWER	+	++	?	
DANDELION GREENS	++	++	+	+
LETTUCE (GARDEN)	++	++	+++	+
ONIONS	?	++	++	
PARSNIP	−	++	?	
PEAS, FRESH	++	++	+++	+
POTATO (BOILED)	+	++	++	
SWEET POTATO	++	+	?	
RUTABAGA	−	++	+++	
SPINACH, FRESH	+++	+++	+++	
" , CANNED	+++	+	+++	
SQUASH	++	?	?	
TURNIPS	−	++	+++	
APPLES	+	++	++	
BANANAS	?	+	+	
GRAPE JUICE	?	+	+	−
GRAPEFRUIT	?	++	++	−
LEMON JUICE	−	++	+++	
ORANGE JUICE	+	++	+++	
PINEAPPLE (RAW OR CANNED)	++	++	+++	
RASPBERRIES (RAW OR CANNED)	*	*	+++	
PEACHES (RAW OR CANNED)	++	+	++	

\+ contains the Vitamin
++ good source of the Vitamin
+++ excellent source of the Vitamin
− no appreciable amount of the Vitamin
? doubt as to presence or relative amount
* evidence lacking or insufficient
V variable

FIG. 231.—(Used by permission of the American Medical Association.)

Lack of the vitamin E seems to limit the reproductive power. The use of the term accessory food substances is preferred by some to the word vitamin. They are also

referred to as protective substances, in that they protect against the deficiency diseases.

It should be noted that milk contains all of the vitamins mentioned. It is fitting that this should be the case, since milk forms the main food of the young, and since it has been determined that vitamin requirements are more important during the growing period than during adult life. They are, however, most important, for the sake of the child, during pregnancy and lactation.

Various substances have been put on the market, and advertised in such a way as to suggest to individuals a lack of vitamins and a means of remedying the lack. Some preparations contain little or no vitamin, others more. Even though they contain much vitamin, it is usually better to get the vitamins from a generous mixed diet, for if the diet is such as not to include enough vitamins, it will be such as to lack other needed substances too. The adult on a generous mixed diet need not give special consideration to vitamins, as may be seen by consulting the table on page 441.

One of the most marked changes in diets in recent years has been the more general inclusion of vegetables and greens. There was formerly a tendency to consider them rather insignificant articles of diet, to be eaten if one liked them, but not because they gave much nourishment. It is true that vegetables and fruit are largely water, but as has been shown, they contain also minerals, vitamins and "roughage" (cellulose) that are essential.

From the vegetable kingdom come the starches and sugars and grains, but they are not classed as vegetables. One vegetable (potato) is usually classed with the starches because of its preponderance of starch. A few vegetables are classed with the proteins (peas and beans) because they have so high a percentage of protein. These vegetables and the very sweet fruits have considerable food value. The others are taken largely for the accessory food factors they include. It is only by the addition of butter or cream sauces that most of them reach a caloric value of any account. But although caloric value is low, nutritional value is high, since they supply those elements without which diet is unsatisfactory.

Vegetables are easy to get in all seasons. It is not only the summer garden vegetables that are desirable. The winter ones supply the same or greater fuel value, and are an equally good source of minerals, of some of the vitamins, and of roughage. Canned vegetables aré equally desirable in respect to fuel value, minerals and roughage, although, with the exception of tomatoes, the vitamins have been somewhat reduced. In a mixed diet such lack will not be felt, however, even if most of the vegetables eaten are canned ones. The process of canning is justly considered one of the most beneficial discoveries in respect to food. No one need fear partaking freely of canned foods as a part of a mixed diet. A diet consisting entirely of vegetables with plenty of milk constitutes a satisfactory diet, in that it provides all the food principles, even though meat is not included. It is not what is called a general mixed diet, however, that term being reserved for a diet in which all ordinary foods are included.

A diet entirely of milk is the most suitable diet for infants, and for some adults, especially during illness. One may live on milk for a long time. It is easily digested, especially if a little carbohydrate is taken with it. Milk may well be used as the basic protein, instead of meat, providing enough is taken, and providing energy-use is arranged for by the addition of carbohydrate and fat (e.g. bread and butter). Fruit and vegetables should be added to give the bulk and the iron not supplied by milk. If it is desirable to add to the amount of the diet, the best food to add is milk, in that it increases protein, fat and carbohydrate, vitamin and minerals, at the same time. If obliged to partake of an unsatisfactory diet for a time, milk may be added to it, to meet nutritional needs.

Foods may be classified, according to their chemical effect in the body, as acid-forming and base-forming. Physicians will often take these effects into consideration in prescribing diet; but in the present state of our knowledge the layman need not do so. The most common error in this respect is the eating of too much acid-forming food. In general it may be said that meat tends to produce greater body acidity, whereas milk, vegetables and fruit (even those that taste very sour) tend to neutralise such acidity. It should be noted that foods which

may be acid when eaten, and have an acid effect in the digestive tract, may, after absorption, be those that increase the

Article of food	Excess acid or base in terms of normal solutions. Per 100 grams	
	Acid (c.c.)	Base (c.c.)
Apples	....	3.76
Asparagus	....	0.81
Bananas	....	5.56
Beans (dried	....	23.87
Beans (lima, dried)	....	41.65
Beets	....	10.86
Cabbage	....	4.34
Cantaloup	....	7.47
Carrots	....	10.82
Cauliflower	....	5.33
Celery	....	7.78
Crackers	7.81	
Eggs	11.10	
Egg-white	5.24	
Egg-yolk	26.69	
Fish (haddock)	16.07	
Lemons	....	5.45
Lettuce	....	7.37
Meat (lean beef)	13.91	
Milk (cow's)	....	2.37
Oatmeal	12.93	
Oranges	....	5.61
Potatoes	....	7.19
Prunes	....	24.40*
Raisins	....	23.68
Rice	8.10	
Wheat (entire)	9.66	

* Prunes, plums and cranberries yield an alkaline ash but serve to *increase* the hydrogen ion concentration of the urine because of their benzoic acid content, this acid being synthesized with glycocoll in the kidney and elsewhere to form hippuric acid.

Fig. 232.—Excess of acid-forming or base-forming elements in foods. (Sherman and Gettler: Jour. Biol. Chem., 11, 323, 1912.)

alkalinity of the body. This they accomplish because of chemical changes which they undergo in the body. So far as

is known at present the value of the base-forming (or acid-neutralising) foods is far greater in other respects than in this, however. In providing for the dietary needs already emphasized, it is likely that a general diet will provide also against increased body acidity.

The diet should vary with age and with the condition of the health. A milk diet is the only suitable one for infants, and often for the aged. An adult at work is generally better off by partaking of all sorts of food, using either meat or milk as the protein basis. Special diets are often needed in special bodily conditions, some of which may be readily and perfectly controlled by adaptations of food to particular needs.

The term "dieting" is used to refer to the limitation of the total amount of food taken. Such a general reduction is sometimes necessary. The adoption of a special diet means the limitation of certain kinds of food, either with or without a total decrease in amount. It should be understood that reducing the total amount of food lessens the quantity of material for repair and for energy use; whereas special diets often disastrously interfere with body chemistry, besides also perhaps affording too small a total amount of food. Neither dieting nor the adoption of special diets (i.e. any departure from the usual proportions of the food elements, either by increasing or decreasing one or more of them) should ever be undertaken without expert advice.

CHAPTER XXXIII

THE HYGIENE OF EATING

Eating depends on one of the most, if not the most fundamental instinct, that of self-preservation, of which the particular aspect that has to do with getting food is called the hunger instinct, or the nutritive instinct. Individuals tend to rely on it, and to eat when hungry what they want at that time. One "instinctively" feels that this is right. Actually it is not always so, for several reasons. Although appetite may be a safe guide for a perfectly well person, it is not always so when body chemistry is changed from normal.

The contractions of the empty stomach are the immediate cause of the sensation called hunger. Ordinarily there is some association between these contractions and the need of the body cells for nourishment. But such is not necessarily the case, as is shown by the fact that a sensation of hunger may be done away with by taking even a small amount of food; and that the sensation disappears long before the body cells could possibly have received the new food materials. If any unusual condition causes the stomach to contract violently, a feeling of hunger that is not valid may arise. The opposite of this may be the case. The stomach may be prevented from contracting as usual, and no sensation of hunger will appear, even though the body cells are very much in need of food.

Appetite is not always a safe guide to the kind of food to be eaten, because foods may be so changed from their usual, natural state as to give no authoritative information to the sense of taste regarding their real nature. If the sense of taste is appealed to by a given food, it appears to satisfy hunger and nutritive needs. Animals and savages, whose food is not elaborately prepared, have more reliable instincts in this respect. If only a few foods were available, and they

were in their natural form, man might be guided more by appetite than is now safe.

Because of the wide choice of food, the tendency to indulge the appetite, and the existence of perverted or unnaturally diminished or increased appetite, it will be seen that the appetite is not always reliable. It is desirable to give some attention to the directing of the appteite and to the supplying of nourishment to the body according to scientific principles. On the other hand, it is possible to study dietary needs too closely and to disregard appetite too completely.

The reliability of appetite is in proportion to the observance of many principles of health (such as the taking of enough exercise and rest), and in proportion to the general good functioning of the body. An appetite that does not attract attention by being noticeably more exacting than usual—that is not too "finicky"—may be allowed fairly free reign when a general mixed diet is provided. It is far safer to follow appetite than to adopt food fads of any sort.

An appetite that is in any way peculiar should be investigated. Some of the disorders of the appetite are anorexia or lack of appetite; bulimia or inordinate appetite; parorexia or craving for certain articles of diet to the exclusion of others. The reasons for these disturbances are numerous, but may usually be determined readily by a physician.

Anorexia is often associated with emotions, some of which tend to limit motor activity of the intestinal tract. This is particularly true of unpleasant emotions, and those that are perhaps pleasant but very intense. Appetite is usually aided, as is also digestion, by calmness, mental relaxation, agreeable surroundings and companions, well-prepared and well-served food. Anorexia is found in many disease conditions, especially those that involve faulty circulation, poor quality of the blood, toxemia (as in colds) and disorders of the intestinal tract.

An increase in appetite is noticeable in connection with a tendency to put on weight. It is also noticeable in conditions that involve a high rate of metabolism. The appetite in such conditions may be extraordinary and the individual remain thin. Such individuals need not fear getting fat. Since

a mild degree of increased metabolism is fairly common, there are many individuals who have enormous appetites which they gratify to the full without any danger of obesity.

Appetite for special articles of food is usually due to changes in body chemistry. When the pancreas is not functioning well, there is often an excessive craving for sweets. A similar craving for sweets may be associated with disturbances of other endocrine glands. Such cravings may not be valid, and the individual so afflicted may be especially harmed by the gratification of the appetite. Sometimes these special cravings indicate a need which should be met, however. Before they are acted upon it is desirable to determine whether such is the case, or the reverse.

It has been noted that appetite which is not present at the beginning of a meal may appear after the soup or the hors d'oeuvre or the fruit is eaten. In fact, it is for this purpose that modern man has become accustomed to take these foods at the beginning of a meal. These substances, that usually can be eaten whether one has an appetite or not, start the stomach acting, so that not only appetite but digestion is improved. Generally speaking, whatever improves appetite at the same time improves digestion, for appetite is intended to be the immediate precursor of the activity of the digestive tract.

The satisfaction of the appetite and the meeting of the needs of nutrition are not, finally, one and the same. One eats for other reasons than to allay hunger. One eats, for example, because the food eaten pleases the palate, and one continues eating, often, after appetite is gone, because the pleasant taste still appeals. Those who overeat usually fail to observe this fact. But those who undereat are too ready to observe the first signs of a departing appetite. The wise individual heeds appetite to a certain extent, although not allowing his unguided appetite to rule over his diet; he also considers to a certain extent the body needs for nutrition, not allowing his imperfect knowledge entirely to overthrow appetite's claims.

Knowledge is for the purpose of aiding the discriminating in making the appetite more reliable, and of teaching him

where, upon occasion, to thwart it. When such thwarting is necessary, the individual might, without the aid of knowledge, come to grief. The needs of the diet should be understood, however, not chiefly for the purpose of thwarting appetite, but in order to be able to satisfy both it and body demands at the same time.

Since eating is a voluntary matter, although usually suggested by the demands of appetite, it should be possible to provide the digestive tract with food with which it can cope successfully. Errors that lead to indigestion are of several varieties. First, the total amount of food may be in excess. If too much is eaten, the best that can be hoped for is that the alimentary tract will reject the excess before attempting to deal with it. This often happens, especially in the young, whose digestive tracts have not become tolerant of excess. The next best that can be hoped for is a sufficient degree of discomfort to call attention to the fact that one has eaten to excess, so that the error will not be repeated. If the digestive tract tries to care for an amount of food greater than it should be expected to care for, it may do so only with discomfort, and imperfectly, producing gases, allowing some of the food to decompose in the intestines, and perhaps giving off toxins into the circulation from the bacterial growth that often occurs in the intestinal tract under such circumstances.

The worst that may happen if an excess of food is eaten is the non-appearance of signs of dietary excess at the time, but the gradual impairment of health due to the cumulative effects of the repeated ingestion of an excess of food. It is thought that the degenerative diseases have some relation to total excess of food. Some degree of gastro-intestinal distress is common in those who overeat. It should be a hint to avoid overeating, and the more serious consequences thereof. In those who rarely overeat, the mechanism for emptying the stomach usually acts to relieve the situation.

Too small a total amount of food leads less often to digestive trouble, the result being chiefly malnutrition. But it may give constipation, because the small amount of food provides insufficient bulk in the intestine. Upon a semi-starvation diet, moreover, gas often forms and gives distention of the

abdomen, which may quickly disappear when a full meal is eaten.

Indigestion also results from wrong combinations of food. Overeating of certain articles of food is more likely to cause symptoms than overeating of others. Too much fat or sweets, for example, is more likely to cause symptoms than too much protein. The meal containing proper proportions of the food elements is not only desirable for nutrition, but for the satisfactory working of the digestive tract. There are few chemical incompatibilities, but many injudicious combinations. (Milk and acid fruit is not one of them.) Injudicious combinations often consist of several different sorts of food taken at the same time, each of which would tax digestion perhaps only a little, but which together tax it too much.

Indigestion may result from eating the wrong kinds of food, even though they contain adequate nutriment. The eating of too concentrated food, with little bulk, is the commonest error of this sort. It leads to imperfect elimination and to constipation which is a common cause of symptoms of indigestion.

An equally serious dietary error is the eating of too much irritating food. A meal of bran, for example, is not safe, although some bran is often desirable in the diet, since it gives bulk. The irritating quality of food sometimes comes from its improper cooking, especially from food that is badly fried, so that it is greasy. Condiments are sometimes a source of irritation to the digestive tract. Their chief value is in their appeal to the appetite. Because of this they may cause an individual to eat when he should not, or more than he should, or to eat food which is not fresh. The most serious defect in the quality of a given food is its spoilage or infection by bacteria. The greatest care must be taken to keep food fresh, which is usually to be accomplished by keeping it on ice, and by not keeping it longer than necessary. Care in the handling of food both publicly and in the home is also of great importance. The government undertakes to inspect certain foods to make sure that they are in good condition when sold.

A theoretically entirely satisfactory diet may not suit a given individual's constitution at all. There are personal idio-

syncrasies that have to be considered. One of the most marked of these is due to a condition known as "protein sensitization." For reasons that cannot always be traced, but that are usually due to a chemical condition produced on the first occasion when the food was eaten, an individual thereafter seems to be poisoned, and actually is poisoned, by a given article of diet that is in itself harmless. The symptoms are sometimes quite alarming although almost never serious. The individual usually learns to avoid that food because of the unpleasant results. The food is sometimes a common one. Some individuals cannot eat strawberries or shell fish or cheese for this reason. Occasionally a tendency to asthma or to skin eruptions may be traced to common foods to which the

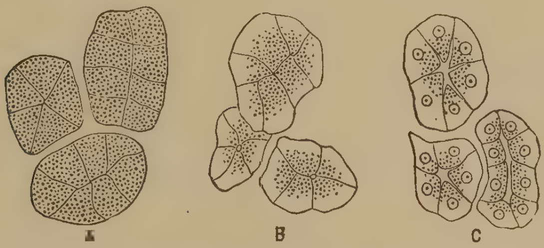


Fig. 233.—Cells of the parotid gland. A, Before secretion; B, in the first stage of secretion; C, after prolonged secretion. (From Halliburton, "Physiology," 15th Edition.)

individual, unknown to himself, has an idiosyncrasy. Physicians are able to determine readily what food, if any, is unsuitable for individual consumption.

Aside from the choice of food, digestion may be influenced in several ways. The process of digestion goes on automatically after it is started, except for the very first part of it, which is carried on by the voluntary process of chewing. It is not necessary to adopt the practice advocated by faddists, of chewing until there is nothing left to chew. Some animals and some humans do not chew much and do not appear to suffer from the results. Generally speaking, food that is not adequately prepared in the mouth is not subsequently as well digested. This is true of starches particularly, in that they require chemical change in the mouth; and of meat and coarse foods, in that

they require subdivision by the teeth in order to be subsequently better digested. One of the advantages dry bread has over fresh hot bread is that it is likely to undergo this desirable chemical action in the mouth; and the chief advantage of tender meat over tough is that it is likely to undergo this mechanical change. Even soft foods and milk should not be taken too rapidly.

One may influence digestion for the better by eating only at the right times and under the right circumstances. This involves, first, eating at meal times, and not at other times. The standard in this country is three meals a day, with an interval of about five hours between each. This interval gives the stomach a chance to rest between its periods of activity. When one's work is largely mental, the heaviest meal is better taken after most of the work is over. If the work is chiefly physical, it should be prepared for by a full meal before it. Other determining factors in regard to the time of the heaviest meal are the occurrence of hunger and of leisure. Generally speaking, one should eat lightly when not hungry or when hurried. Ordinarily it is not desirable to eat much just before going to bed, as it may interfere with sound sleep, although a small amount of food may aid one in falling asleep. Somnolence comes on in some individuals immediately after eating.

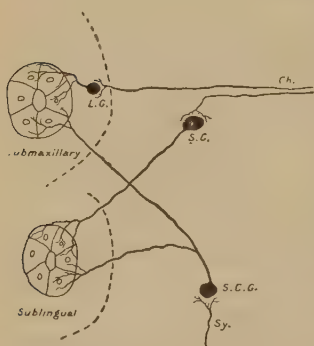


FIG. 234.—Diagram of salivary glands with the secretory nerves that supply them with impulses. (From Halliburton, "Physiology," 15th Edition.)

Those who are somewhat below par often do not care for breakfast, probably because the function of the alimentary tract is not sufficiently aroused early in the morning to enable much food to be digested. An effort should be made to keep the health in such a state as to permit active functioning of all organs as soon as one is awake. An effort should also be made to find some foods that are acceptable in the morning. Milk, at least, may usually be taken. If too little breakfast is

habitually eaten, a midmorning lunch should be a regular habit.

Regularity with respect to mealtimes is quite important, for the rhythmic action of the intestinal tract, at certain hours every day, is a valuable adjunct to digestion. It is better to eat at one's regular hour, even if very little is taken, than occasionally to omit meals entirely. Omitting a meal regularly is not so objectionable from the point of view of digestion, although it may be more objectionable from the point of view of nutrition.

The overweight individual sometimes does better on a two-meal diet. On the other hand, those who are underweight often must establish a five- or six-meal diet in order to get enough nourishment. It is often arranged so that the individual has three meals at the usual hour and additional food between breakfast and lunch and between lunch and dinner, and perhaps at bedtime. The extra food, if taken regularly, is not classed as eating between meals. It should consist usually of milk and crackers and fruit. If one is habitually hungry at such times, this sort of five- or six-meal diet should be adopted. The individual who is hungry but does not need more nutritive material should usually confine his eating between meals to the taking of fruit only, and should certainly not include candy and sweets. No dietary habit is more unsettling to the digestion than eating anything that is offered at any time of the day.

It is generally considered better not to eat just before or after hard physical or mental work or bathing, because in these circumstances much of the blood is elsewhere than in the digestive tract and the food remains undigested until later, during the interval perhaps causing discomfort. For those who are not strong, or whose digestion is easily disturbed, it may make a great difference with respect to nutrition, if an inadequate blood supply is furnished the alimentary tract during digestion. For all persons there should be, preferably, a short interval of mental and physical repose just before and after meals. If five minutes only may be secured for sitting quietly at rest, it should be taken. This amount of rest will usually enable the digestive tract to deal well with

the food that is particularly needed by the mentally or physically fatigued. The delay in service of meals may be accepted as an advantage rather than as a cause for impatience.

Sometimes individuals say they are "too tired to eat." If after a short rest one is still averse to eating, it is often better not to eat. But that means taking more rest at once, rather than continuing work without food. If one is too tired to eat, one is too tired to work any longer. It is the weak, the fatigued, and the anemic individuals who suffer most from indigestion, but who most need adequate nutrition. They, at least, must carefully consider both dietary and eating habits.

Failure of digestion may result from eating while in a mood unfavorable to digestion. The effect of powerful emotions is often such as to limit the motility of the stomach and the intestines, and their production of digestive secretions. Indigestion may continue if the emotion is prolonged, or may become chronic if the emotional state is not improved. If it cannot be immediately regulated, the diet should be adapted to the circumstances. Care should be used to eat easily digested food while one is tense or "unstrung." Even quite insignificant emotions, such as may be produced by arguments of an exciting nature at mealtimes, may temporarily hamper digestion. There are those who suffer some bad effects from the minor emotion of loneliness when eating in solitude. Pleasant companionship and mildly agreeable conversation should be sought when possible.

Finally, digestion may be aided by maintaining the activity of the circulation, so that it will supply quickly all the needs of the functioning digestive organs. It is largely by doing this that exercise and good posture improve the general nutrition. Without enough exercise the quality of the blood and of the digestive juices and the motility of the digestive tract are likely to be impaired. Poor posture, as it affects the heart and respiration, the position of organs and their circulation, is often at the root of faulty digestion.

The varieties of indigestion already mentioned are entirely functional. It should be noted that the same disturbance of function may result from organic disease in the alimentary tract or elsewhere in the body. Indigestion is a common

occurrence with such varied sorts of ailments as anemia, inflammation of the appendix, or lung tuberculosis. It is desirable to bear this in mind in presuming to diagnose one's symptoms as simple indigestion, even though one thinks he knows exactly what dietary or hygienic error precipitated it. This is particularly true of persistent or prolonged indigestion. It is never out of place to discuss a faulty digestion with a physician, although the aim should be to conduct one's life so that the digestion does not fail.

CHAPTER XXXIV

NUTRITION

Malnutrition may be defined as a state of the body in which the cells do not receive or cannot use enough material for their growth and proper functioning. The lack is a diffuse one in which all of the cells of the body are involved to a greater or less extent. If the material supplied to the cells is lacking in certain particular food elements, the malnutrition involves some tissues more than others. For example, if certain vitamins are lacking, there will be present an inability to use certain mineral salts, and the bony tissue will suffer most. In such cases the fat tissue is often not undernourished at all. Children with rickets have been used in advertisements as examples of good nutrition.

The commonest type of malnutrition is undernutrition, and the most frequent single cause of it is an actual lack of a sufficient quantity of food. As a matter of fact, there are often many causes combining to produce it. If, for example, the small amount of food that is taken is not of the right sort, undernutrition becomes still more pronounced.

During the past two decades the problem of undernutrition in children has been much discussed and many efforts have been made to prevent it. The result is that fewer babies and children are undernourished than formerly. But coincidently with the improvement in the very young, there arose a fashion for extreme slimness in adults. The prevailing mode, especially followed by women, has become one that demands a thinness ordinarily found only in those who are undernourished or ill. A large number of those who correspond to the mode in weight are actually either undernourished or ill.

Along with the extreme thinness, called by courtesy slimness, these individuals show other signs of the undernourishment of the cells of the body generally. They are often sensitive

to the cold, unusually susceptible to fatigue, lacking in endurance and vigor, unable to stand strain and exposure and equipped with little resistance to infection. What may be gained in beauty of form (beauty according only to a perverted standard, however) is usually lost in beauty of face. The color usually needs artificial aids, the features look more or less pinched, wrinkles appear early, the eyes look dull and lifeless. The effect is often one of approaching age, rather than of youth. The appearance of the undernourished is not that of sophistication, which seems to be desired at present. There is no glamour about a hungry, underfed look; it suggests exactly what it is, and nothing more romantic. Furthermore it indicates, when self-induced, a degree of vanity that suggests serious personality defects.

The earliest recognition of the need of adequate nutrition was by those who observed its effect in preventing tuberculosis. Those who voluntarily limit food intake below what is needed to keep the tissues nourished are trifling with a disease that comes far more readily to the undernourished than to any others. Since most people have tubercle bacilli in the body, and only those whose resistance is lowered have the disease itself, lowered nutrition may be considered as important a factor in causing tuberculosis as the tubercle bacilli themselves. Nutrition is the variable factor; the bacilli, the constant one. Nutrition is the controllable factor; the bacilli, the relatively uncontrollable one.

For many reasons it is important that an individual get and maintain adequate nutrition. This does not mean necessarily that one must correspond to any given standard of weights, but that there must be evidence that the individual is well nourished.

There is considerable variation in weight according to type of stature, according to racial and family differences, and according to the activity of the endocrine glands that influence weight. Some races and some families tend to produce uniformly plump individuals. Another race or family will be notable for its lean, wiry men, and its scrawny, angular women. The difference among races or among families of these two sorts does not appear necessarily to constitute a difference in vital-

ity. It is merely a difference in type of stature, either compatible with good health, although each type requires somewhat different hygiene and is capable of somewhat different achievements.

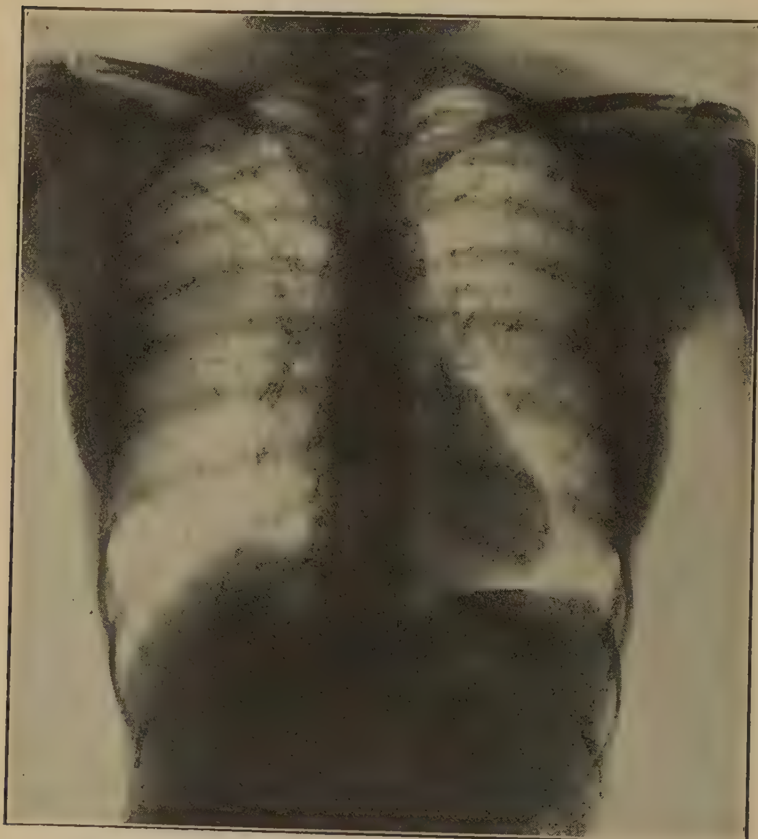


Fig. 235.—X-ray of chest, showing slender bones.

An individual who comes of a "stocky" family will be likely to be "stocky" too. If he weighed as little as the tables indicate he should, he would probably be, for him, somewhat underweight. The long, rangy individual, who is actually by the tables underweight, would possibly be overweight if he weighed what the tables indicate.

Part of this difference in individuals is due to the inheritance of a larger frame. Bones weigh a good deal, and any general increase in their size and weight makes considerable difference in the total weight of the individual. On pages 458–9 X-rays

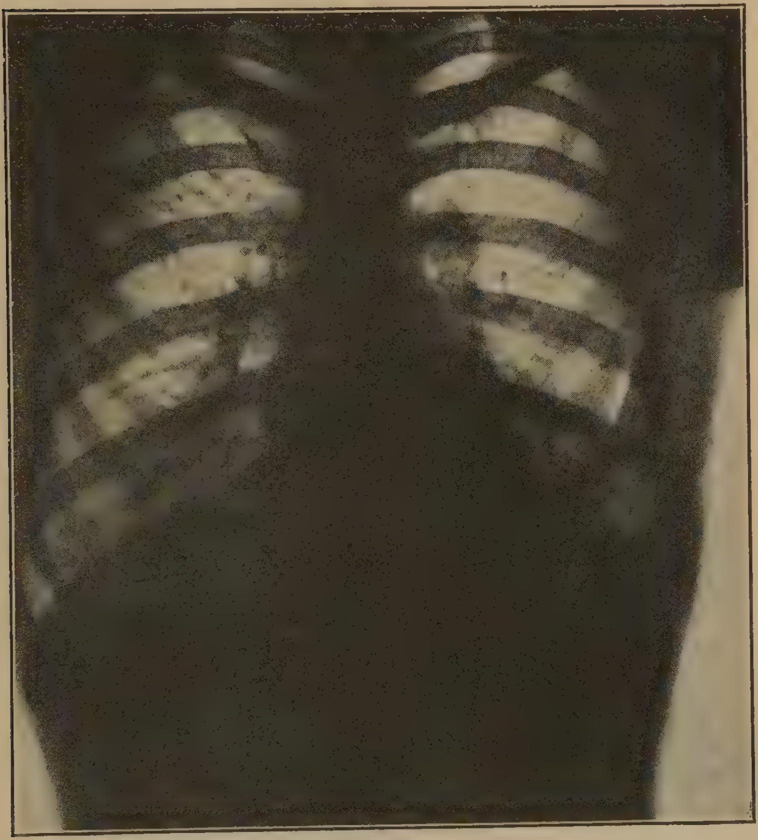


Fig. 236.—X-ray of chest, showing heavy bones.

are shown of the bones of the spine and thorax. Note the heavy vertebrae and ribs in one, and the slender bones in the other. The individual with large bones usually has also larger muscles. These two factors produce a more bulky person who weighs more for his height than the average. An estimate of

the size of bones and muscles should be made before it is concluded that an individual is over or under weight. Efforts to reduce or to gain in weight can produce no possible change in the size of bones, and very little in muscles. Only fat tissue is to any marked degree influenced in quantity. Although increasing or decreasing food allowance changes individuals chiefly in respect to fat, as far as size is concerned, the bulky individual, who on less food loses some fat, may undergo an undesirable change in the quality of his tissues.

Women, height for height, as a rule weigh less than men, largely because the frame is usually lighter. The difference in frame is recognized as usually existing between the two sexes, but not always as among individuals of the same sex. A heavily built individual cannot expect and should not expect to weigh the same as a more lightly built one of the same height. He will be malnourished if he does.

Sometimes girls of the Amazon type trifle dangerously with their nutrition because they do not recognize that their bones and muscles, not their fat, are making up their extra weight and that since the former cannot be greatly reduced, reducing the latter implies malnutrition and possibly emaciation. If they succeed in reducing enough to reach weight-table standards, they will both look and feel sick. The individual who needs reducing is the one who, although he may not weigh enough to violate the tables very seriously, is yet "pudgy" and soft.

Heredity not only influences the size of the skeleton, but also the tendency to the deposit of fat. It was formerly thought that obesity itself was hereditary. Now it is thought that it is merely a tendency to obesity that may be inherited. Such tendencies may be dependent on the inheritance of an endocrine system that fails to maintain the balance of metabolism.

Aside from the actual lack or excess of food of the right sort, variations in endocrine gland secretions form the largest single cause of variation in weight. It is because of changes in these secretions that certain individuals remain thin on a full diet, and others gain weight on a light one. Exercise and dieting seem to have less effect in reducing excess weight, and the opposite practices to have less effect in increasing weight,

when there exist in the individual tendencies established by the endocrine glands, to keep the individual over or under weight.

If a normal diet, a fair amount of exercise and sleep, and good general health habits do not cause the weight to be about what it should be, abnormalities in the condition of some organ of the body should be thought of and sought for. If the tendency is toward obesity, it may very probably be of endocrine origin, and may perhaps be righted through medical treatment. If the tendency is towards underweight, there may be an endocrine disorder; or there may be disorder of almost any organ for most ill health leads to poorer nutrition.

In order to determine the status of one's nutrition, it is necessary, first, to find out how one's weight varies from the supposedly normal; second, whether the supposedly normal is one's own normal; third, whether the variation represents actual under- or overnutrition; fourth, why the under- or overnutrition has occurred. It will be seen that it is not enough to consult a table, and then to eat either more or less. The question is much more than one of food.

The gauging of one's weight by comparison with tables of weight is justifiably the first step to take in considering one's nutrition. There are tables, drawn up by those who weigh and measure large numbers of individuals, that indicate what the average person of a given height usually weighs at given ages. Furthermore, by a comparative study of the health averages and weight averages, and by comparing the health of individuals at various weights in relation to age and height, it has been possible to determine what weight is most likely to lead to the best health. In this way optimum weights have been computed. It has been found that large numbers of individuals do better at about a given weight for a given height and age, feel better, are less often sick, and have longer expectation of life. In other words, the weight tables represent weights that for the average indicate adequate nutrition. The weights given cannot be considered to be ideal for each individual. They represent merely an effort to establish some standard by which to gauge weight, weight being in itself only one of the indices of nutrition.

MEN.—Height-Weight Averages

Height	16	17	18	19	20	21	22	23	24	25–29	30–34	35–39	40–44
4 ft. 10 in.	...	...	...	...	...	...	...	...	...	...	...	...	...
4 ft. 11 in.	...	...	...	...	...	...	...	...	...	...	...	...	...
5 ft.	101	103	105	107	110	112	114	116	118	122	126	128	131
5 ft. 1 in.	106	108	110	112	115	117	119	121	123	124	127	130	133
5 ft. 2 in.	111	113	116	117	120	121	122	123	124	126	130	132	135
5 ft. 3 in.	115	117	119	121	124	125	126	127	128	129	133	135	138
5 ft. 4 in.	119	120	122	124	127	128	129	130	131	133	136	138	140
5 ft. 5 in.	124	125	126	128	130	131	132	133	135	137	140	142	145
5 ft. 6 in.	128	129	130	132	133	134	135	137	139	141	144	146	149
5 ft. 7 in.	133	134	135	136	137	138	140	141	143	145	148	150	153
5 ft. 8 in.	137	138	139	140	141	142	144	146	147	149	152	155	158
5 ft. 9 in.	141	142	143	144	145	147	148	150	151	153	156	160	163
5 ft. 10 in.	145	146	147	148	149	151	153	155	156	157	161	165	168
5 ft. 11 in.	150	151	152	153	154	156	158	160	161	162	166	170	174
6 ft.	155	156	157	158	160	162	164	165	166	167	172	176	180

WOMEN.—Height-Weight Averages

Height	16	17	18	19	20	21	22	23	24	25–29	30–34	35–39	40–44
4 ft. 10 in.	92	94	96	98	102	105	107	109	111	113	116	119	123
4 ft. 11 in.	95	97	100	103	106	108	110	111	113	115	118	121	125
5 ft.	102	104	106	109	111	112	113	114	115	117	120	123	127
5 ft. 1 in.	108	109	111	113	115	116	117	118	119	120	122	125	129
5 ft. 2 in.	113	114	115	116	117	118	119	120	121	122	124	127	132
5 ft. 3 in.	117	118	119	120	121	121	122	123	124	125	127	130	135
5 ft. 4 in.	120	121	122	123	124	125	126	127	128	129	131	134	138
5 ft. 5 in.	123	124	125	126	127	128	129	130	131	132	134	138	142
5 ft. 6 in.	126	127	128	129	130	131	132	133	134	135	138	142	146
5 ft. 7 in.	128	129	130	131	133	134	135	136	138	139	142	146	150
5 ft. 8 in.	132	133	134	135	136	137	138	139	141	143	146	150	154
5 ft. 9 in.	135	136	137	138	139	140	142	144	146	147	150	154	158

FIG. 237.—Note that these tables represent average rather than ideal weights. (Adapted, and slightly modified, from tables by Dr. Thomas D. Wood, with his permission.)

It should be recalled that the tables indicate general standards, and do not state anything at all about the significance of a departure from them. They do not even hint as to the cause of a departure, and least of all do they suggest a remedy for the condition. From a physician one should seek confirmation of the fact that the weight is not normal; examination to determine the cause; and advice as to the remedy, which may or may not involve change in dietary or exercise habits. Other changes in habits may be called for; or perhaps no such change at all, but medical treatment be needed. In the case of the over-weight, the anguish of semi-starvation may be unnecessary. In the case of the underweight, unrecognized illness may have to be corrected in order to make any increase of food effective in improving nutrition. If the living habits, including the dietary ones, are normal and one still varies from the general standard, no procedure can be considered logical that does not involve first an investigation of the cause.

Scales are of less use in diagnosing the state of nutrition than in gauging progress when scientific efforts are being made to change the weight. They are used daily to gauge the growth of babies, since in infancy health is particularly indicated by steady growth. Even with babies other signs of good nutrition and good health are to be taken into consideration along with the weight. The opinion of an observing person, especially of a physician, on inspecting either a baby or an adult is perhaps a better guide than the use of scales and the comparison with tables. For no matter what the tables seem to indicate, if an individual has a general appearance and expression of well-being, good color, clear skin, bright eyes, firm muscles, and erect posture, he is likely to be well nourished whatever his weight. If, regardless of his weight, he lacks these signs of health, those who observe him would think of either malnutrition or of disease. It is because of the association of malnutrition and disease that malnutrition, whether shown by weight or in other ways, should be taken seriously.

Although many other factors than food influence malnutrition, food cannot be considered as other than the fundamental factor in many cases. In other words, many individuals are undernourished chiefly because they eat too little, or do not eat

the right kind of food. This is called primary malnutrition, because of its direct relationship to food. Secondary malnutrition is that due to various health conditions unfavorable to the utilization by the body cells of even an adequate diet. The differentiation between these two types of malnutrition is important to have made, if disappointment is to be avoided regarding the results of increasing the diet.

If in a given case the undernutrition has been attributed directly to inadequate food, it may be found that there is either a deficiency in the total quantity or that the diet is qualitatively unsuitable. It is customary to consider malnutrition one of the almost inevitable accompaniments of poverty. But it is as much a matter of judgment as of money. Malnutrition is almost as common among the rich as among the poor. It is possible to obtain a well-proportioned diet, and one providing enough calories, for a small amount of money; and it is possible by ignorance to deprive one's self to a degree that would arouse the sympathy of the charitable—were it not often a voluntary ignorance, or even a deprivation in spite of knowledge, in a mistaken expectation of gratifying vanity.

Secondary malnutrition, in which other factors than food are at fault, may be due to other faulty habits of living, so that even a good diet does not nourish. Nutrition involves more than the mere taking of food of the proper kind in proper quantities. It involves its assimilation by the body cells. Anything in the habits that interferes with this final step in nutrition may be considered as a cause of secondary malnutrition. On an identical diet, nutrition may be much influenced by such habits as relate especially to sleep and exercise, sunlight and fresh air. Furthermore, the same amount and kind of food may be eaten at such times and under such circumstances that, although digestible, it is not digested.

Fatigue, in particular, needs comment in a discussion of malnutrition. Whether there is indigestion as a result of eating when fatigued, or a reduced total intake as a result of lack of appetite when fatigued, nutrition in either case is likely to suffer. In overfatigue the appetite is likely to be capricious, which often leads to a capriciously chosen diet.

Rather than to endanger digestion and nutrition, it is preferable, even, to take only liquid foods which will sustain nutrition without upsetting digestion. Sometimes, however, it is beyond the power of appetite, digestion or nutrition to improve while overfatigue continues. A perpetual, although slight, amount of overfatigue may keep the individual perpetually slightly malnourished, so that every organ, including the brain, functions less well, the individual weighs less than he should, and shows his malnutrition in his appearance.

Finally, secondary malnutrition may be due to malfunction or disease almost anywhere in the body. The condition may be such that the digestion is unable to deal with, and the body to be nourished by, a regular mixed diet. Such a condition may not, however, interfere with nutrition by a specially modified diet. In some disturbances of the alimentary tract itself, undernutrition results from food chosen without consideration of the disability of the digestive tract. Most conditions that cause indigestion tend also to cause malnutrition, unless easily digested foods are chosen and a sufficient quantity eaten.

Those who have been interested in nutrition work for undernourished children have observed how often malnutrition cannot, in a given case, be corrected by increasing or improving the diet, because the malnutrition is related to focal infection. One of the results of the bacterial poisoning from such foci as infected tonsils is often a degree of general cell malnutrition that shows as underweight as well as in many other ways.

Before nutrition can be improved, in many cases it is necessary to clear the way for improvement. The mere taking of more food may be hopelessly discouraging unless the individual is "free to gain," in the words of a prominent nutrition expert. This term, "free to gain," implies the removal of all obstacles to the securing of adequate nutrition by means of an adequate diet. It involves, first, getting rid of organic or functional disease; and second, renouncing hampering hygiene habits. The diet is simultaneously considered, but the results of a good diet may not appear until one is entirely "free to gain." Since a gain in weight is usually one of the best indices

of a gain in nutrition, the center of attention is usually fixed on what the scales indicate. To the individual, however, much more important evidence of improved nutrition comes through the subjective feelings of increased energy and endurance.

The diet of an individual who wishes to gain should, first, represent enough calories. It may be desirable to estimate about what one is eating on several average days, to see whether the calories are sufficient. Often the reason for underweight will be found to be partly due to the taking of food affording several hundred too few calories a day. In supplying more food, it is better to add some of all the food elements, rather than to add a good deal of a single food element. Usually the adding of milk to an ordinary mixed diet is the best procedure. Adding to each meal one roll and butter and a glass of milk affords about three hundred additional calories, which is frequently enough to raise an insufficient diet to a satisfactory caloric level. Care should be exercised not to throw out either the balance of the food elements or the digestion by adding chiefly rich foods or sweets. Such foods have high caloric value, but do not provide the best means of improving the diet.

Since the habit of slight overfatigue is common in the undernourished, a short period of idleness before and after meals is recommended for them, as an aid to digestion and for the other effects of rest. Taking rest at such times interferes least with the daily work, and benefits health most. If the rest may be taken lying down, so much the better. The undernourished individual particularly needs a considerable amount of sleep, whatever amount for him produces a thoroughly refreshed feeling in the morning.

Because of the effect exercise has in promoting metabolism and thus causing the consumption of tissue, the underweight individual should guard against too active exercise, even though it does not appear fatiguing to him. The danger of undernutrition itself is as much to be guarded against as the danger of overfatigue. Actually, the undernourished individual often does habitually overfatigue himself by exercise without observing it, partly because the temperament is one that enjoys activity and abhors anything that savors of

"babying" or invalidism. But even the undernourished seldom should be deprived of all exercise, because exercise itself is necessary, in suitable amounts, in order to ensure nutrition. A careful balance of rest and exercise is a factor in nutrition second only in importance to an adequate diet.

It is desirable to investigate an habitual state of underweight, to ascertain whether it represents undernutrition.

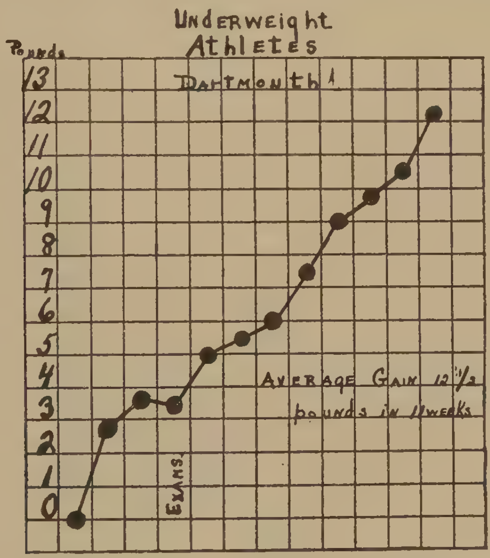


FIG. 238.—Average gain in weight of 17 underweight athletes. These men had the special objective of gaining weight in order to "make the team." (From article by Dr. W. R. P. Emerson in the Dartmouth Alumni Magazine, February, 1925.)

It is absolutely essential that a recent and continuing loss of weight be investigated, even though it is so slight as hardly to be noticeable except when comparing the weight over a considerable period. It may be found that the loss is due to seasonal variation and the accompanying changes in diet and other habits; but it may be an indication that the health needs special consideration for a time.

Being slightly overweight in early adult years, is far less hazardous to health than being underweight. In fact, it is both a normal and desirable condition. Evidence from many

sources, including statistics of life insurance companies, seems to point to the fact that those who have the best health in youth are those who are a little above their weight as estimated by the tables, and that these individuals have better health

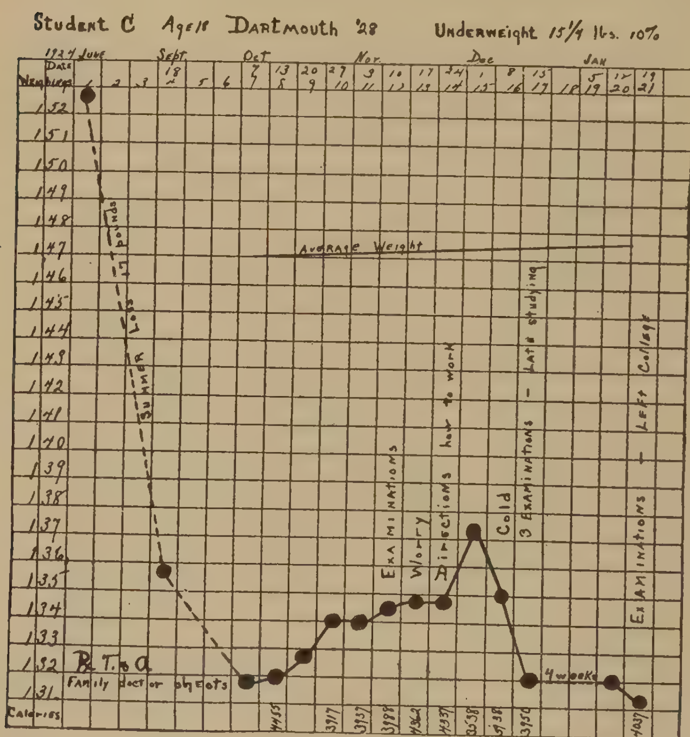


FIG. 239.—Illustrating the effect of entering college in poor physical condition and not "free to gain." Left college after passing examinations. Had diseased tonsils which his family physician did not think should be removed; these may have been the cause of his poor condition. (From article by Dr. W. R. P. Emerson in the Dartmouth Alumni Magazine, February, 1925.)

prospects for the future. Under 30–35 years of age, therefore, a slight excess should not seem like a calamity from the health point of view.

After the ages 30–35, the reverse is the case. The individual of middle age who is slightly underweight seems to be

better off than the one who is overweight. The aim should be, then, to accept gratefully the early excess, while watching it to see that it does not increase at what should be the most active period of life, but that at that time gradually decreases a little. The menace of overweight comes chiefly at and after middle age.

It should still be borne in mind, however, that there are various types, depending on heredity and on endocrine supply, for whom this rule is not applicable. Given a certain type of stature, both in respect to bones and muscles and fat, and the individual may through life be well, while always distinctly over or under weight according to tables.

The main causes of overweight are less numerous than those of underweight—the latter often depending, as has been shown, on ill health of some sort that would not at first glance seem to be related to nutrition at all. Overweight, if slight, is quite generally merely a sign of good health. If more than slight, it is due to a disparity between intake of food and its metabolism. This disparity is either voluntary, and controllable by hygiene; or it is involuntary, depending on the body processes of metabolism as determined by the endocrine glands. On the supposition that the disparity is controllable, the common remedies for overweight are, thus, lessening the intake of food and increasing metabolism by exercise. That these measures do not always succeed is because of the other possibility—that the endocrine glands are keeping metabolism on so low a plane that even violent exercise does not raise it to a level where it will balance the intake of food. What often happens is that the appetite is increased by the exercise, so that more food is taken, while the metabolism is not proportionately increased. On an exercise regime the overweight individual may actually gain weight, unless great care is taken not to increase the food also.

Practically all cases of extreme overweight (obesity) are thought to be endocrine in origin, as are also many cases of moderate plumpness, especially of that which comes on at middle age. The effect of the endocrine disorder in such cases is to slow the oxidation of food eaten, and to cause it to be stored as fat rather than to be burned as fuel.

One who is overweight is not, however, necessarily at the mercy of his endocrine glands; or perhaps is not completely at their mercy, even though they are influencing his weight. Medical science is able to deal with overweight of this sort in many cases, and should be given a chance to do whatever may be done.

The other cause of overweight, faulty hygiene in respect to food and exercise, is often found as the sole cause, the endocrines being in perfect order so far as may be determined. It is for this type of individual that the advice concerning methods of reducing is about to be offered. That which is suggested may have little effect if the endocrines are at fault. On the other hand, any measures that involve improvement in general health may help to establish the normal function of these glands. The defect in their function is sometimes so slight that it tends to right itself spontaneously if the health is made as good as possible. A very stout individual should not, however, undertake anything extreme in the way of reducing without medical advice. There are numerous ways in which the body may be actually harmed by measures that produce no results in loss of weight. Reducing medicines, for example, should not be taken without advice. Most of them are futile, and those that are not contain the extract of an endocrine gland that increases metabolism, which should only be taken when it has been determined that it is necessary to meet a body need, and while the individual is under medical supervision to forestall any possible harm. The endocrine gland extract affects other body functions than metabolism, therefore does more than reduce weight. The other effects, such as changes in blood pressure and heart action, should be watched for by someone who knows what to anticipate.

The individual who is more than approximately 15 per cent overweight should make an effort to keep within this limit, for obesity has its penalties as has undernutrition. Among the unfortunate results of obesity is, first, the burden of the excess fat. It hampers the free activity of the body tires muscles and joints that have to carry the weight about, leads to foot troubles, and generally makes exercise unpleasant. Although the increased weight may have been partly due to

lack of exercise, and although exercise is often necessary to cure it, exercise is more burdensome and unpleasant than usual. This makes a vicious circle—little exercise, increased fat; increased fat, less exercise, etc. In addition to this, the heart and abdominal organs may be pressed upon by fat, the diaphragm become less freely movable, and circulation and digestion be consequently interfered with. The obese are often sluggish both physically and mentally, need much sleep, are easily winded, easily fatigued, and subject to gastric and intestinal indigestion. In order to carry on the nutrition and the circulation for so large a body the heart may have to pump harder in order to develop a higher blood pressure. Perhaps it may be prevented from doing this because of fat deposits and deterioration of its muscle, in which case the circulation fails because of the weakened heart. All in all, a condition of obesity is one to be avoided, by watching for the earliest signs of a tendency in that direction, and preventing its further development. As has been mentioned, the slight but constant overweight of adolescence and early adult life should not be interpreted as the earliest sign of obesity, for such overweight is likely to give way to normal weight later. The earliest sign of a tendency to obesity is a weight more than 20 per cent above normal, which increases readily when exercise habits are relaxed and diet increased, or in spite of good habits.

It is much better to prevent obesity than to allow it to develop and then to try to cure it, for its cure is both difficult and unsatisfactory. In order to keep "in trim" the diet and exercise should be carefully regulated, so that no more food is eaten than is oxidized. If, by errors in these directions, an individual has already passed the limits of normal weight, he should try to get back to normal, not as quickly as possible but as safely as possible. This means "reducing" gradually. It is not wise to try to reduce more than a pound or two a week usually, because the whole system must have a chance to adapt itself to the new regime. Those who commence a reducing regime in the middle of the week, hoping to become sylph-like by the end of the week, are doomed to disappointment. It is impossible, and would be unwise if it were possible, to reduce so rapidly.

It is permissible for those who have no symptoms except their overweight to begin, first, with a gradual reduction in diet and a gradual increase in exercise. The reduction in diet should be particularly in respect to sweets and other carbohydrates, if one has been eating too much of them. Otherwise, it should be in respect to the total amount, omitting a little here and a little there.

Those who put on much weight are often very fond of sweets. If they were to compute the number of calories they consume in a day, they would often be surprised to find how many are added by yielding to this temptation to self-indulgence. The obese should begin their efforts at reducing by omitting candy and cakes entirely.

The next step in reducing is to refuse all food of any kind between meals, except that which satisfies the appetite without having any particular food value. If it seems necessary to take something between meals, the more watery fruits should be taken. Sometimes it is possible to quiet a gnawing appetite by merely drinking water.

At mealtime, the total number of calories may be much reduced by omitting the bread and butter at dinner and by limiting it at other meals. Very sweet desserts should also be omitted. Potatoes should be taken only in small amounts. Fats should be limited to what is already in the food as it is served. Butter and cream should not be added at the table. Vegetables of low nutritive value and much bulk (such as celery, cabbage, asparagus, cauliflower, onions, etc.) are the mainstay of those who wish to reduce, since they allay hunger without increasing the calories afforded.

It should be borne in mind that it is generally the total amount of food that is to be reduced. Those who religiously avoid certain articles of food may, by having second servings of others, more than make up for the calories omitted. No single article of diet need be entirely omitted, providing that in any one day one does not get too many calories. Knowing that carbohydrates are particularly likely to cause fat deposits, somewhat more attention should be given to avoiding an excess of them than of other food. But there is nothing poisonous about carbohydrates that makes them totally unsafe

for obese individuals. If for social reasons it is necessary, because little else is offered, to eat more carbohydrates than one would wish to do, one may balance the temporary excess by abstention for the rest of the day.

No single article of food by itself is "fattening." It only becomes so when its association with other food causes it to be a part of a too large day's ration, or a part of a carbohydrate excess. Even candy itself would not be fattening if it were a part of a low-calorie diet. The reason it is better omitted entirely is because it is usually taken in addition to other food, the total number of calories being raised to too high a level by the concentrated carbohydrate represented by candy. No other food so inconspicuously overbalances and overloads the dietary as does candy.

Generally it is better for those who are overweight to omit fluids at meals, because fluids enable one to eat more food, even though the fluid is not used to promote hasty eating. Soup at the beginning of a meal, because it increases the appetite, may also be omitted. Cream soups sometimes, however, allay appetite so that less of the more highly carbohydrate foods are craved. It is desirable to make a point of chewing the food thoroughly, in order to make a small amount of food last longer—perhaps while others are having second servings.

It is often true that the excess weight is due to only a small excess of food, and before cutting down the diet too much, one may try to see whether, by making small changes, hunger cannot be satisfied without increasing the weight. Even two hundred calories a day more than is required may be enough to add steadily to the weight if an individual is so predisposed.

There are no magical reducing diets. The simple principles mentioned offer all that is needed. The individual who is reducing should have a table of caloric values of various foods, and lists of the food elements contained in various articles of diet as they appear at meals (see appendix). Much foolish limiting of diet is done in ignorance of the contents of foods and their caloric value.

It should be realized that the individual who is reducing may be kept from being hungry. It is never necessary to suffer an empty or "all gone" feeling. As to the satisfaction of

	Calories
Walter Baker, Vanilla Sweet Chocolate (10 cent cake)	629
Park & Tilford Chocolate (10 cent cake)	641
Stollwerck Chocolate (10 cent cake)	490
Milk Chocolate (10 cent cake)	220–460
Nut Chocolate (10 cent cake)	157–524
Soda Waters	
Ice Cream (with Cream)	
Chocolate, chocolate ice-cream	443–467
Chocolate, chocolate ice-cream	251–377
Chocolate, vanilla ice-cream	314–374
Fresh strawberry, vanilla ice-cream	436
Vanilla, vanilla ice-cream	394–399
Vanilla, vanilla ice-cream	202–385
Soda Waters	
Plain	
Chocolate	172–268
Vanilla	239
With Cream	
Chocolate	357
Chocolate	109–247
Vanilla	134–230
Vanilla	167
Sundaes	
Chocolate ice-cream:	
Chocolate sauce, walnuts	327–516
Fudge sauce, walnuts	412
Marshmallow sauce, walnuts	383
Marshmallow and chocolate sauce, walnuts	429
Maple walnut sauce	235
Strawberry sauce	225–235
Strawberry ice-cream:	
Fresh strawberry sauce	277–406
Strawberry sauce	257
Strawberry sauce and marshmallow	412
Vanilla ice-cream:	
Fresh strawberry sauce	334
Marshmallow sauce, walnuts	350
Chocolate sauce, walnuts	396
Marshmallow sauce	251
Chocolate sauce, nuts	371
Strawberry sauce	304
"Soft" Drinks	
Ginger ale—15½ oz. bottle	136
Grape juice—1 pint bottle	398
Moxie—1 pint, 10 oz. bottle	322

Fig. 240.—(Table used in an article by C. G. and F. G. Benedict "The Energy Content of Extra Foods." Boston Medical and Surgical Journal, August 1, 1918.)

preferences of appetite, not so much can be said. Lack of willingness to deny one's self in regard to special foods is at the root of much failure.

Although a thin individual usually loses weight quickly when the diet is diminished and finds it hard to gain even on the most bountiful diet, the individual who is inclined to be overweight is likely to find the opposite the case—he gains easily and loses slowly. Either of these tendencies should be noted, and one's attention given to avoiding that variation from normal which is for one's self most likely. It is often observed that those who are most concerned lest they should not get enough to eat are those whose chief danger lies in getting too much, whereas those who would have to devote a good deal of attention to it in order to get up to normal weight, deprive themselves needlessly to an uncomfortable and unsafe degree. A thin individual should try the effect of eating as much as he wants, within hygienic limits. The chances are that he may even then not reach normal weight unless he modifies a good many other living habits too. The overweight individual will find the difficulty exactly reversed. He may eat as little as he can, and yet not get down to normal weight unless he also changes a good many other habits.

Since overweight is due to a disparity between intake of food and its oxidation, the process of increasing metabolism is as important as the reducing of food. Metabolism is chiefly increased by exercise and by cold baths. That exercise is best which uses the most of the body. Sports are desirable if one can drop out when the early fatigue and breathlessness, common in the obese, comes on. If no exercise has been habitually taken, it will often be found that breathlessness comes on very early. It is defeating one's own ends to keep on after that point. Such an individual should exercise for the short time his wind permits, but at more frequent intervals. Weekly or bi- or tri-weekly exercise does very little good in reducing. It must be daily, and sufficient in amount slightly to tire but not to strain or exhaust. If there is any question about the latter point, a physician's advice should be secured.

The fat are often totally uninterested in exercise for years perhaps, until something arouses them to reduce. The violent

exercise they may then take up often is much too violent for the possibly flabby, fatty heart muscle. Any sporadic exercise is likely to have no beneficial effect, but may have many harmful effects. In order to be useful for reducing purposes, exercise must be regular, and as vigorous as the individual can stand. Many of those who are overweight spare themselves a good deal of incidental exercise in the course of the day by allowing others to do for them everything that represents expenditure of energy, and by riding when they might walk.

Massage is not as good as exercise, but may be used as a supplement to it at the beginning of a reducing regime when the heart will not stand very much exercise, or for attacking local fat deposits.

Cold bathing has the same effect as exercise in increasing metabolism, if it produces a good circulatory reaction. If it does not do so at first, it is worth while trying to become accustomed to it, since it does a great deal to keep down superfluous fat deposits. It is far more effective than the very hot or steam baths that are popularly considered useful for such purposes, but have, on the contrary, the effect of lowering metabolism. In the case of only moderate overweight, the change from daily hot baths to daily cold ones may be all that is needed.

The overweight individual is often inclined to be sleepy. He should make an effort to get rid of the cause of the sluggishness, rather than yield to it to the extent of taking more than the customary eight or nine hours of sleep. A physician may be of assistance in suggesting the remedy for such sluggishness, although often it goes away of itself when the diet is reduced and exercise and cold bathing increased.

The results of such a regime may not begin to appear for weeks, but having achieved normal weight, the regime, including the diet, should be continued until the weight has been constant at the right point for some time. Usually the exercise and bathing habits should be continued permanently, although it may be possible to increase the diet gradually without causing a corresponding increase in weight. By careful experimentation one should be able to establish a diet that is not noticeably different from the average and is satisfying

to the palate, although it will probably not be found possible ever again to include more than a very limited amount of sweets.

There is no specific dietary change that in any miraculous way will cause the obese rapidly to lose weight. Neither are there any other miraculous ways of reducing. Nothing rubbed on the body, or applied to its surface, causes "absorption of fat"—advertisements to the contrary. Rubber garments, by the pressure they exert, have some effect, but the perspiration that collects under them is not the "fat melting away." Any garment that presses very tightly causes the tissue under it to decrease somewhat in volume, but in the areas where such pressure is usually applied, it is usually harmful. It is better to rely on diet and exercise rather than on pressure. Local fat deposits (as on the hips) tend to disappear under general exercise. Such procedures as rolling on the floor afford only a small fraction of the effect on the large muscles of the hips afforded by the exercise involved in playing a game of tennis.

As has already been implied, to allow one's self all through the year to get fat, and then to spend two or three weeks, perhaps during a vacation, or preceding certain social or other occasions, in reducing by starvation diet and violent exercise is likely to be very injurious. What is sought in reducing is not merely the lowering of the weight, but the normal functioning of the organs that should accompany their normal nutrition. Allowing them to deteriorate by allowing one's self to get fat is in itself objectionable; suddenly and violently forcing a reduction of weight adds insult to injury. The vacation of the overweight individual should not, on the other hand, be such as to add still more to the weight.

The aim of both the fat and the lean should be to strike a balance between intake and oxidation of food that will keep them as near as possible to normal without making the question of weight of too engrossing interest. It should be possible to reach a state where the weight remains constant and the habits that keep it so are an automatic not unpleasant part of one's life.

CHAPTER XXXV

THE HYGIENE OF EXCRETION

Excretion is a property of every body cell. Each cell gives off its waste into the blood. As the blood then circulates through the body, various kinds of waste are taken out of the blood by the lungs, skin, and kidney, and given off from them. In addition, waste material is given off from within the body by the intestinal tract, most of it never having actually gotten into the blood or the body cells at all.

The lungs excrete carbon dioxide and water without special efforts at elimination. Both are present in all cells as the result of all metabolism. The carbon dioxide is passed out of the blood into the lungs, and from there is automatically breathed out. In the exhaled air is also some of the excess water, in the form of vapor.

The skin gives off much water, but usually not enough other waste to class it among the organs that excrete poisons. The hygiene of the skin is discussed elsewhere.

The kidneys are the chief organs for excreting the potentially poisonous products of cell activity. They are among the most important and active organs of the body. It requires an enormous amount of cell activity to take the urea and other materials from the blood and change them into urine for excretion.

The kidney waste differs from that of the bowel in that the former represents body waste and only indirectly the waste of food eaten, whereas the latter represents food waste directly.

The liver is classifiable among the accessory organs of excretion, since it prepares much of the waste for removal by the kidney.

The kidneys are rather susceptible to disease, especially to overstrain and to infection. Overstrain it is thought may come about by giving them too much work to do. Their

work is greater in eliminating nitrogenous waste than in eliminating other kinds. There is evidence that some experimental animals show increase in size of the kidneys on a high-protein diet, which, however, does not necessarily imply actual injury to the kidneys. It is probably desirable to avoid too great an amount of protein food. It is generally thought that meat once a day provides a sufficient amount of protein, although it must be said that some races eat much more and do not suffer especially from kidney disease. It is probable that other factors associated with excessive meat eating bear an important part in any weakening of the kidney that follows. For example, those who eat meat in excess are often those who live hard, either at work or in dissipation, and eat a total excess of food, while not getting enough exercise. It is desirable to avoid too great a total quantity of food, as well as too great an amount of meat. Red meat is only slightly harder, if at all, for the kidney to deal with.

Although exercise is desirable in activating all organs, too violent exercise may tax the powers of any organ. Kidney function may be changed by extreme bodily activity, which may be followed by the transient appearance of albumin in the urine, indicating that the kidney has permitted protein from the blood to pass through it, in addition to the usual nitrogenous waste. If too hard physical work were persisted in, the kidney might partly lose its ability to hold back the blood protein adequately. Sugar may also appear in the urine after excessive exercise, the liver having released a very large amount to the blood. On the whole, too little exercise is more likely to be injurious to the kidney than too much.

There is one other way in which exercise may lead to kidney impairment. If, while very warm after exercise one suddenly becomes chilled, the kidney may temporarily cease to function because of inflammation in it. It is a much less common result of chilling than is inflammation of the respiratory tract, but sufficiently frequent to be mentioned as one of the dangers of chilling. Although the chilling may result from long exposure to cold, it is more likely to follow sudden exposure to cold when the body is warm. Infection may follow after chilling, if bacteria gain access to the kidney through the blood

or otherwise, and the kidney possibly be permanently damaged. The kidney is subject to infection even when not chilled, sometimes as a part of general infection, even of one no more severe than a cold. It may also be the site of more serious infections, such as tuberculosis.

An important way in which kidney function is impaired is by poor posture, especially that sort which compresses the lower chest and causes sagging of the organs. The kidney is ordinarily quite firmly attached to the posterior wall of the body and does not "float" or sag. If it does so, its circulation is perhaps so interfered with that it becomes permeable to the protein in the blood, as is not normally the case, and passes some of it through in the urine as albumin. It may also pass glucose into the urine in such circumstances. The correction of the posture usually relieves such symptoms, and prevents further damage to the kidney from that cause.

The intake of too much alcohol also tends to damage the kidney by causing degeneration of its cells. Poisons of many sorts do this, even some of the poisons produced in the body or absorbed from an unhealthy digestive tract. One of the most serious results of auto-intoxication involves both the heart and the blood vessels, as well as the kidney. A large number of the deaths at too early an age are due to the combined degeneration of these three important parts of the body. Often it cannot be determined just which is involved first; but whichever it is, the kidney sooner or later suffers when heart and blood vessels deteriorate. The commonest cause is absorption of poisons, those already mentioned and also bacterial poisons from foci that perhaps themselves give no particular trouble.

There are many patent medicines advertised to cure kidney disease. They usually suggest that a pain in the back is probably due to trouble in the kidney. Such is not the case, except in rare instances. One is usually not aware of kidney trouble except by the results of urinalysis. Medicines should, of course, never be taken for the kidney except on a physician's prescription.

To avoid injuring the kidney it is desirable to avoid burdening it by giving it too much work to do. A total excess of food,

and probably an excess of nitrogenous food in particular, adds to its work. The kidneys must also be protected against having to deal with highly concentrated solutions. This is accomplished by drinking a good deal of water. Substances that go into solution with difficulty will not be fully excreted unless they are contained in a large volume of water. Finally, the kidneys are aided by a sufficient amount of exercise, and by good posture. Whatever improves the general circulation should have some effect in improving the health of the kidney, as of all parts of the body. Urinalysis is advisable once a year to make sure the kidney is in order, or upon the appearance of any symptoms.

The matter of water drinking is of much importance. It is necessary that all the fluid given off from the body by lungs, skin and kidney be made up daily by an equal intake of fluid, or at least an amount that compensates for normal fluid elimination. This is, on the average, about 1500 cubic centimeters a day. From two to four quarts of water should be taken to make sure of making up for this loss. Any excess of water will merely be excreted, usually to the kidneys' advantage rather than their harm.

Sixty to seventy per cent of the body by weight is water, seventy-five per cent of the active organs, such as the brain, muscles and liver, is water. Ninety per cent of the plasma of the blood is water. The amount of water in the blood is constant and must be kept so. If not enough fluid is taken in, fluid is taken from the tissues, and the tissues and their fluid suffer accordingly, in order to keep the blood characteristics unchanged.

There is need of water in the body for a number of purposes. It is necessary for the purpose of keeping the blood fluid so that it will flow, carrying nutriment, waste, internal secretions, and other materials from one part to another. It is necessary in order to keep the cells normal and active. Protoplasm is semi-fluid. If the cells are too dry, chemical activity in them is less. Water is necessary to provide the fluid base of all the moisture on mucous, serous and synovial membranes. It is also necessary to form perspiration to regulate temperature. Since the digestive juices and intestinal secretions are

fluid, water is necessary in order to provide a fluid base for them. Nutrition could not go on unless there were enough fluid to make the food capable of absorption. Dissolved food only can be absorbed. There is less absorption on a dry diet. Finally, water is necessary to make fluid the waste in the intestinal tract so that better elimination takes place.

Insufficient intake of water results in damage to the kidney, for the kidney needs that diluted rather than concentrated waste pass through it. The bladder also may be irritated by too concentrated urine.

One could live only a few days without replacing the fluid lost. It is possible to live much longer without food than without water. The instinct of thirst has arisen so that water drinking will not be neglected. It is felt in the mouth, but usually indicates need for fluid all over the body. In some cases thirst indicates a dry mouth and throat only.

Theoretically, one could take enough water in food, but actually one is not likely to do so. There is considerable fluid in some foods, especially vegetables and fruits; but it is ordinarily necessary to take water, or those beverages that count as water. Milk is a food which requires digestion, in that it becomes coagulated soon after it reaches the stomach and therefore is not included in computing the daily amount of fluid. Tea, coffee, and most beverages are included among fluids, as is also clear soup. Although some beverages meet the fluid requirements, for other reasons they are not usually a perfect substitute for water.

The customary routine in regard to taking water is to drink some upon arising in the morning and retiring at night, between meals when it is convenient, and at meals. It has been quite definitely settled that water at meals is not harmful. In fact it is an aid to appetite and digestion. Naturally it should not be used to enable food to be swallowed before it is thoroughly masticated. There is no objection to ice water, even at meals, providing a great deal of it is not drunk at once before or during a meal. In such a case, digestion might be delayed until the stomach warmed up.

Huge quantities of water are advocated by some healing cults. If an individual believes his health requires inordinate

amounts of water, or if he is inordinately thirsty, he should have medical advice. No form of self-medication, even by water, should be used. It is not entirely harmless in some disease conditions to drink an excessive amount—in fact, in some rather rare conditions it is a danger. The water-drinking fad is, however, probably the least harmful of health fads.

Unless more palatable, hot water usually has no particular advantage over cold water. It may, in some cases, serve to stimulate the digestive tract in the morning better than cold water. One may take either, but preferably not large quantities of water that is either too hot or too cold. Boiled water, although not necessarily taken while still hot, is a safeguard if there is any question of the purity of the water.

The chief advantage of mineral water is that it is water. The minerals, except in such highly medicated water as Pluto, are negligible. It is less expensive to get one's minerals in the diet. Mineral water is not needed by the well; and any ill person should consult a doctor before prescribing even mineral water for himself. Many mineral waters, so-called, contain less of the mineral they are advertised to contain than the natural waters supplied to cities. If chemicals are needed, it is better to get them from a known source in given amounts, or to take mineral waters only on prescription.

Spring waters are nothing but a luxury for those who live in cities supplying purified water. There is no spring water more pure than most municipal supplies, and it may be less pure through contamination in the bottling process.

There are individuals who say that they are never thirsty. This, however, does not mean that they should not drink. Others say they do not like water. This, too, should not prevent the taking of enough fluid in some palatable, non-injurious form. Soda fountain beverages may or may not contain harmful chemicals. Sometimes there is the complaint that water drinking produces a feeling of weight and distention in the stomach. This should be investigated, as the stomach may be dilated, and possibly less water should be taken at a time. It is usually due, however, to the presence of gases in the stomach. Hot water may be better borne than cold in

such circumstances, since the hot water may break up the gas combinations. If drinking water on retiring causes bladder activity during the night, it may be omitted then, providing enough is taken during the day. In such a case, an examination of the urine should be done, since it should be possible to drink at bedtime without having to pass urine during the night.

The chief danger from water is due to possible bacterial contamination. Water from wells or springs should not be taken unless one is certain of its purity. Most modern municipal supplies are sufficiently purified to be free from the danger of typhoid, the most serious disease carried by water. An individual changing from one supply of water to another may experience some intestinal symptoms until the adjustment to the new water is made. This may be the case even though the new water is perfectly pure.

EXCRETION FROM THE INTESTINE

Elimination of waste from the colon usually takes place once a day. The fecal material contains remnants of food that was either undigestible or undigested. Cellulose, the fibrous material found in vegetables and grains and fruit, which animals but not man can digest, constitutes the largest proportion of food residue, if a normal diet is taken.

Constipation is a term used to describe infrequency of evacuation. It also may imply fecal material that is drier than usual, often in small amount, and difficult of evacuation. In many cases of constipation there is both delay and change in the character of the material. There may be delay in evacuation, but the material be moist or even semi-fluid; and there may be no departure from regularity, but the stools dry, hard, difficult to pass, and insufficient in bulk.

The latter condition is usually due to one of two causes; either not enough fluid was taken with the food, or the fluid was too fully absorbed during too long a stay in the colon. It is often possible to demonstrate by X-ray that in such a case the food eaten takes an unusual length of time to pass through the intestines. By giving a substance with the meal that casts a shadow, such as bismuth, photographs may be taken at

different times to show the progress of the meal onward toward evacuation. It is therefore possible to determine whether delay takes place or not, and at what part of the canal. The term used to describe this delay is stasis, which means halting.

Intestinal stasis may result in a daily evacuation of rather dry material, but the material gotten rid of may be the remains of that eaten several days before; whereas an active alimentary tract gets rid of the material daily that was eaten in the previous twenty-four hours. It should not necessarily be concluded that the intestine is active because there is a daily

a b c

Fig. 241.—*a*, Ptosis of the alimentary tract. Note position of stomach, small intestines and colon; *b*, dilatation of the lower end of the colon; *c*, dilatation of the caecum.

evacuation. Not only may fecal accumulations be seen by the X-ray, but they may often be diagnosed in other ways by physicians. This matter should be settled if there are any symptoms to suggest inadequate elimination, even in spite of regularity.

The causes of constipation may be in the intestinal tract itself. There may be lessened motility of the muscle coats, due to their lack of tone; or there may be deficiency of secretions. There may be a sagging of the whole intestine that makes its evacuation mechanically difficult. This is often found in those with poor posture. Constipation may be due to the character of the food. This often occurs when the food is lacking in bulk, which is particularly likely to be the case if

few vegetables are eaten. It may also be due to a low fluid intake.

Some general conditions of the health diminish both motion and secretion in the intestinal tract. Constipation is common in those with generally poor health, anemia and poor circulation. It is common in the "nervous" and those of a worrying disposition. All depressing emotions tend to cause constipation. There is also constipation during most acute illnesses and fevers. In appendicitis there is likely to be constipation, which may be either the result or the cause of the inflamed appendix.

The sequel of delay or stasis in the intestinal tract is likely to be putrefaction of the delayed waste, by the action of bacteria feeding on the protein residue. Toxins may be absorbed into the body along with fluid from waste, injuring the circulatory system, kidney, and liver, and increasing susceptibility to disease of these organs. Inflammation of the intestines may occur, giving occasional attacks of diarrhoea. Bacteria may ascend to the pancreas or lodge in the appendix, and cause disease in these organs. Hemorrhoids, or piles, may result from the pressure on the veins about the anus, which causes them to dilate. Pressure of retained material causes the muscles of the intestine to lose tone, and the motor and sensory nerves to become progressively more inactive, so that constipation becomes, after it has continued some time, a state difficult to overcome.

The symptoms produced by constipation are those that are classed as dyspepsia. They are so common as hardly to need enumeration. Symptoms that are not commonly traced to constipation, but are, nevertheless, often due to it are changes in the disposition and mental powers. Drowsiness after meals and poor sleep at night are common results. The intestine may act as a focus of infection from which may arise ailments of various sorts—such as rheumatism or anemia.

After having dwelt upon the possible harm from constipation, it is necessary to mention the fact that the fear of constipation is almost as bad as the condition itself. It produces a state of the nervous system in which constipation is still more likely to occur. Many get along very well without

daily evacuation for a while. Only those should fear constipation who are doing nothing to correct it.

All that is needed in many cases to cure constipation is due attention to the necessity for evacuation. Any suggestions from the colon should be heeded at once, or it will not be so ready to act at a later time. It is desirable to be prepared for spontaneous, effortless evacuation shortly after meals, because at that time the motion that has started in the intestinal tract is felt even as far as the colon. There is some aid that may be given by voluntary muscles; therefore conscious attention should not be engaged about anything else at the time. If the toilet seat is so high that the knees are not slightly higher than the hips, the voluntary muscles cannot be used to advantage. This difficulty can be remedied by the use of a foot stool. With these few habits corrected it will often be found that the bowel is capable of regular and full action. It may be necessary, however, to change a few more habits.

The diet in constipation should contain foods that have a considerable cellulose residue. This bulk gives the intestine something on which to contract firmly and improves its muscle tone. For this purpose all sorts of vegetables and fruits are desirable, and the whole grains in bread and cereals. In addition to supplying bulk, the materials mentioned are mildly irritating and thus stimulating to the intestinal muscle coats. In fact in some cases of disease of the intestine they should not be used on that account. It is quite safe for the average individual to partake of them freely in a general mixed diet. A whole meal of bran cereal is not, however, desirable. It might be so irritating as to give diarrhoea, or further constipation by exciting spasm of muscles. Gas formation and a distended abdomen are particularly likely in a too meagre diet or one lacking in bulk.

The fruits have also another advantage in that their acid has a mildly laxative chemical effect. Oranges, grapefruit, apples, etc. are of advantage because of their fibre and because of the laxative acidity. Prunes contain particularly laxative substances. There is no one diet that will cure all constipation.

The value of water has already been mentioned. It gives bulk, but more particularly it softens the fecal mass, so that

it is more easily evacuated, providing there is not so much delay that the water is mostly absorbed.

In addition to attention to the diet, one should also give attention to posture and exercise. Poor posture, by permitting sagging of the abdominal viscera, may be the sole cause of constipation. Every effort should be made to widen the lower chest and to pull the abdominal muscles tight, to hold the organs in and up. It is unusual to see a bulging abdomen and

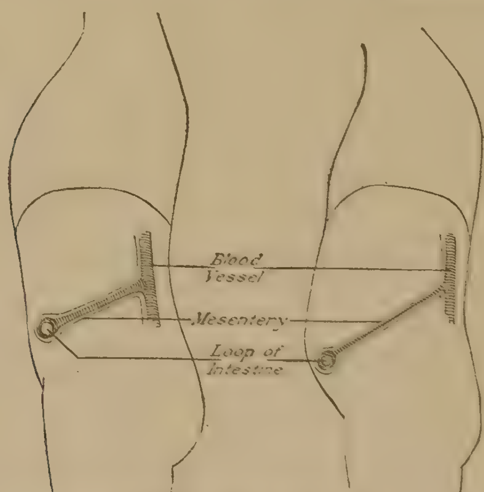


Fig. 242.—Showing how improper posture favors visceroptosis: the mesentery is stretched and the circulation to the loop of intestine is lessened. (From Williams, "Healthful Living." By permission of The Macmillan Company, Publishers.)

contracted chest in an individual free from constipation. The converse is equally true.

Sometimes a well-fitted girdle, that gives upward and inward support, is necessary while learning to hold the abdomen properly. In men, occasionally an abdominal support is essential. These are not usually ordered, however, unless study of a case reveals that ptosis (sagging) is the chief cause, and that it cannot be readily corrected otherwise, or that its ultimate correction demands training in this way.

Improper pressure of clothing may have a very detrimental effect on the position of the intestines and their freedom to

move. Either a corset or girdle or belt or even an elastic around the waist in bloomers may hamper intestinal action and favor a downward pull on the viscera.

Exercise to combat constipation should be both general and local. General exercise that activates circulation and promotes health generally, and that gives a mild jolting of the abdominal contents, is most desirable. Walking, running and jumping exercise, as in games and riding, do this.

FIG. 243.—Prominent abdomen in a weak individual with ptosis. (From Jones & Lovett, "Orthopedic Surgery." Courtesy of William Wood & Company, Publishers.)

Local exercise of abdominal muscles is often called for, however. This is for two purposes: first, to strengthen the muscles; second, to exert pressure on the intestinal contents. All sorts of twisting and turning exercises, that bring abdominal muscles into play, are desirable, as well as voluntary contraction of abdominal muscles in the upright or recumbent position.

Massage and kneading of the abdomen with the hand are also beneficial. This may be done at any time, but is particularly useful while making efforts at elimination. With the tips of the fingers one should begin low on the right side and press inward and upward, across the abdomen at just below the waist level, and downward on the left side. This follows the route of the fecal material through the colon, and if properly done, should aid its passage. A more diffuse massage with the palm of the hands is also desirable.

Cathartics are necessary upon occasion. For example, they may be needed in emergencies such as acute illness, when

every effort is made to make it easy for the body to combat infection. Sometimes cathartics are used to start the habit of elimination once a day. If there are symptoms either of absorption or of irritation it is sometimes necessary to free the intestine of accumulated waste. Such irritants often produce diarrhoea; nevertheless a cathartic may be given to eliminate the irritant quickly.

Cathartics act in various ways; some by starting up a very lively motility of the intestinal muscles, some by abstracting enough fluid from the intestinal wall to aid in the onward movement of the contents, some by lessening the usual absorption of water by the intestinal wall. There are very many cathartics from which the choice should be made according to the particular circumstances. No one cathartic is suitable, or will even produce results, in all circumstances. When needed, cathartics are the most serviceable drugs available, but when not needed, they are most pernicious, for many cathartics are habit-forming. Along with the good effect temporarily achieved, they may create, if continued, a condition of the intestinal tract that tends to make it more and more difficult for it to act normally unaided.

If cathartics or laxatives must be taken for a time, the dose should be reduced as soon as possible, until they are gradually entirely discontinued. This is particularly true of those that abstract fluid from the alimentary walls. After a dose of salts, a day or two of unusual dryness of the intestinal wall occurs, accompanied by more constipation. Salts should therefore be followed on succeeding days by other measures to counteract this dryness, for example by mineral oil. Constipation particularly follows the use of cathartics that excessively stimulate peristalsis. They tire the nerve-muscle mechanism and make it less susceptible to moderate stimuli. Furthermore, they so completely empty the bowel that the stimuli are less than usual on the following day and no movement takes place.

The enema consists of injection into the colon of water containing dissolved soap—or other substances, according to a physician's advice. The enema constitutes an emergency measure prescribed occasionally by physicians, and not a

hygienic device to be used at any regular intervals. Its effect also is to reduce the responsiveness of the bowel to moderate stimuli on the following days, on which days it usually must be followed by some other measures to empty the bowel.

There are a few cathartics or laxatives that do not seem to produce any adverse conditions, and that may be used for prolonged periods, if necessary, without creating the habit of constipation. Among these is cascara sagrada, which may be taken in pill form, or better, as the fluid extract, from ten to thirty drops in water, from one to three times a day, or only at night. If this is taken, parallel efforts should be made to encourage normal activity of the bowel without it, and to discontinue its use finally.

There are two substances used to increase bowel activity that do not properly come under the heading of drugs, in that they act entirely mechanically. They are mineral oil and agar-agar. The former merely lubricates the intestines and surrounds and permeates its waste with oil—the oil not being absorbed and having no effect on the intestinal wall. It may be taken regularly with no bad effects, although the conditions that make it necessary should be corrected if possible, because the same conditions may be leading to other bad results that are not so easily corrected. For example, if the need for mineral oil is due to faulty diet, lack of exercise or poor posture, these matters should be corrected for the sake of other kinds of harm they may do besides the more easily corrected constipation. Olive oil is digested and absorbed and does not act so well as mineral oil.

Agar-agar, a variety of Japanese seaweed, also acts mechanically, its effect being due to the bulk it supplies in the intestine. It supplies more bulk than the ordinary diet that is not particularly chosen with this in view. It may be taken as agar biscuit or in various other ways. It is also prepared in combination with mineral oil, which usually controls constipation successfully with the minimum of harm; in fact, with no harm except the possible overlooking of the cause of the constipation, which, as has been emphasized, should be corrected regardless of the possibility of correcting constipation itself.

Diarrhoea is a condition in which the bowels move more frequently than usual, the material being more or less watery, and its passage accompanied often by crampy sensations in the colon. As has been mentioned, it is frequently due to the effects on the bowel wall of constipation, in which case it alternates with constipation, both recurring frequently. It may, however, be an acute condition due to various forms of irritation and inflammation of the tract. Whereas the depressing emotions cause lessened motility, the more violent ones such as fear may cause excessive motility. Diarrhoea is most often associated with irritation from food. Injudicious combinations, a total excess of food, indigestible food or food contaminated by bacteria may each produce a spontaneous effort at getting rid of the irritant.

Sometimes diarrhoea seems to be due to no other cause than chilling of the body occasioned by exposure while warm, or perhaps by a sudden change of weather. Sometimes it seems to be due to a change of water, although the new water may be pure. Those whose metabolism is very rapid, as when the thyroid is secreting very freely, may have unusual frequency of bowel movements.

The effect of too frequent elimination is to produce a considerable loss of fluid from the body and a degree of weakness that may even result in fainting. Because the food taken is given off so quickly, little absorption takes place and nutrition temporarily suffers.

The correction of a tendency to diarrhoea is by the removal of the causative condition, whatever it may be. In many cases it involves getting rid of an irritant as quickly as possible, by castor oil or by enema. Meanwhile no food should be taken or very little, and that of a non-irritating character. Because of the weakness and the small amount of nutriment that may be taken, it is safer to remain very quiet. Habitual or recurring attacks of diarrhoea should always be investigated. Some of the more serious infections of the intestine, such as typhoid, are often accompanied by diarrhoea and constitutional symptoms. Any attack of special severity or with other symptoms than those of the intestinal tract should be investigated.

CHAPTER XXXVI

CLOTHING

There are many reasons for clothing apart from that of health maintenance, and many factors other than hygienic ones that influence the choice of clothing. This has been so since clothing was first adopted by the human species. Yet for whatever reasons clothing was first worn and continues to be worn, and whatever motives underlie the choice of clothing, it cannot be denied that coincidently the clothing put upon the body has its effect on the physical and the mental health of the wearer.

As to the original reasons for the use of clothing, one may find evidence that it was first used for purposes of adornment, to satisfy the aesthetic sense of the wearer or to make the wearer more attractive to the eyes of others, especially of the opposite sex. It is but a step from painting and tattooing the body, to decorating it with fur and feathers, and only another step to the finery of modern times that represents the labor and skill and interest of so vast a multitude of people.

One may also find evidence that clothing was originally adopted in response to a dawning sense of modesty. The evidence would be more convincing if it could be shown that there was any universal sense of modesty. In various times and places clothing has covered various parts of the body, and apparently as a result of this habitual covering of certain parts, various peoples have developed modesty regarding the parts covered. Among Europeans, for example, the sense of modesty does not demand the covering of the face, as it does among Turkish women. Among women in America and Europe at the present time the sense of modesty is not such as prevents the wearing of skirts that leave uncovered a considerable portion of the legs. From year to year, with changing

style and habituation to different ways of dressing, the sense of modesty becomes greatly modified. Part of the difficulty between older and younger individuals is that two generations may by habit have two entirely different concepts of what modesty demands.

There is also evidence that clothing has always served the purpose of differentiating one class from another, or of indicating economic status. Primitive man or woman may have taken much pride in flaunting social position or wealth by wearing of those garments unattainable or not permitted to humble folk. This use of clothing survives, and forms the basis of much striving for an appearance that will proclaim or even falsify one's social or economic position.

The idea of wearing clothes for comfort seems also to have had a part in determining their original use. Yet comfort seems to have included little besides protection from cold, and clothing has been worn where comfort would have suggested the opposite, as in the tropics.

Even though clothing perhaps prevented discomfort from cold, other forms of discomfort produced by the clothing itself seem to have been endured with equanimity, so long as the clothing met other standards. It is surprising how much discomfort was tolerated. There is ample evidence that some of the styles in clothing that were worn for generations, although intrinsically uncomfortable, were not recognized as being so by those who had compelling reasons for wearing them. It is probable that the present unhampering and healthful clothing of women had its origin in experiments in the direction of comfort.

That clothing affected health has always been apparently of little significance, except in those respects where comfort and health-promotion happened to coincide. Nevertheless, although health has never been much considered in choosing clothing, much of the clothing that has been worn has been distinctly disadvantageous to health. It is now possible to follow the prevailing mode, established no one knows how, and to be comfortable and well at the same time. No other consideration need be set aside in order to adapt clothing to health.

The most important way in which clothing affects health is by its effect on temperature regulation. The intricate mechanism whereby the body maintains its constant temperature, and the reasons for the constant temperature have been discussed in Chapter XV. The body, if well, can adapt to almost any external temperature, but it is inevitable that any material worn over the skin should change the activity of this mechanism. Clothing may be such as to aid the natural process of keeping warm or of keeping cool, or it may be such as to make either task more difficult. The second way in which clothing affects health is by its effect on posture. The relation between clothing and posture is quite close, as is also its relation to freedom of body motion. Finally, clothing has an effect on the cleanliness of the skin, and its freedom from injury and irritation. Contact of the skin directly with many sorts of inevitably dirty objects is prevented by the wearing of clothing, which may be removed and washed. If the whole body were exposed as are the hands and face, the task of keeping free from infection would be greatly increased.

With these three main health considerations in mind (heat regulation, freedom of motion and protection), the question of the choice of clothing may be discussed.

From the point of temperature regulation, the aim in choosing clothes should be to assist rather than hamper the efforts the body makes to adapt to varying temperature conditions. Enough clothing should be worn in cold weather to spare the body to some extent the task of producing heat, and a sufficiently small amount in hot weather to enable the body easily to get rid of the excess. Comfort is an important guide if it is heeded, but as has been mentioned, it is not always comfort that dictates the choice of clothes, and the sense of comfort may be perverted.

The harm of too much clothing is as great as the harm of too little. Too much clothing results in an elevation of surface temperature, and ultimately to some degree of the temperature of the interior of the body, unless it is compensated for. To get rid of the excess heat, perspiration takes place, which in itself is disagreeable in amounts that are apparent, and which predisposes to chilling. The symptoms produced by too much

clothing are very similar to those produced by foul air—dullness, drowsiness, headache, and lack of energy. In fact the excessive warmth about the body is responsible for the symptoms in both cases.

The overclothed individual suffers from the lack of the metabolic efforts which would otherwise be called into play to produce heat. Because less heat is gotten rid of, less is produced. Lacking the stimulus of having to produce heat, the stimulus is also lacking to many organs to do their work properly. The overclothed baby is apt to suffer from indigestion in the summer, the cause being sometimes entirely due to its clothing, and sometimes partly to that cause and partly to improper food.

Generally speaking, the infant and the aged need more clothing because of their less stable temperature regulation. But they are often too much bundled up. The feeble also need more, but often not as much as they think. Those whose metabolism is high require surprisingly little, as, for example, those with an increase of thyroid secretion. Those whose metabolism is low need more clothing. If too much clothing is habitually worn, the body is too much spared, and becomes sensitive to temperature changes. Clothing should be reduced to the minimum that secures comfort, and that permits easy and satisfactory temperature regulation, without too greatly taxing the system in its efforts to keep the body warm. The amount varies in different people, according as they "feel the cold," according to the way in which the body has been educated, and according to the other motives for wearing much or little. Style and pride at present are less likely to lead to an overabundance than to too scanty clothing.

Too little clothing may result in causing the individual to catch cold, but this is less likely if too little is habitually worn. Irregularity in amount is much more likely to have this effect. The harm of too little clothing is that much of the energy producing material and much of the activity of the body must be used to maintain temperature. Too much energy is spent merely in keeping warm. The underclad individual must eat more and exercise more in order to keep comfortable and well. If he does not eat and exercise more, he may be able to stand

the discomfort of being cold, but his vitality and resistance to disease may be appreciably lowered. This is particularly true if the individual has little fat tissue under the skin, that in itself provides a sort of protective covering against the effects of cold.

The amount of assistance or interference given the heat-regulating system depends more on materials of which clothing is made than on the number of garments worn.

Materials used for clothing are from the vegetable kingdom,—cotton, linen, wood fibre (artificial silk); and from the animal kingdom—wool, silk, fur. Generally speaking, those from the animal kingdom are warmer than those from the vegetable kingdom. All materials are classified according to their power to conduct heat away from the body and their power to absorb moisture. It will be noted that no materials actually produce heat for the body. They can merely retain it near the body, if they are poor heat conductors.

Those materials that are poorest in heat-conducting power (hence feel warmer on the body) are those that contain much air in their meshes. Dry air is a poor conductor of heat. Wool is intrinsically a poor conductor of heat, but in addition wool is usually woven in such a way as to contain air. Hence wool material seems to be warmer than others. But silk and cotton may be woven in such a way as to be warmer than they usually are. Cotton blankets so woven as to contain air, seem much warmer than ordinary sheets that are closely woven. Taffeta silk seems very cold compared with the silk jeresy of which underwear is made. Even wool, however, may be so closely woven as to contain little air, in which case it loses some of its warmth.

The second factor in material, that of absorbing moisture, is equally important in determining body heat. Materials vary in the degree to which their fibres will take up moisture, those from the animal kingdom usually taking up more. Wool takes up most. It feels warm not only because it does not conduct heat away from the body but because it keeps the body dry by taking up its moisture, and by itself giving off the moisture slowly. Evaporation is in inverse proportion to absorption.

When evaporation from the body, or from a material on the body, is rapid, the surface feels unduly cool, as may be proved by wetting the hand or by putting a layer of wet cloth on the hand and fanning it. No other material has all three heat-retaining qualities to quite the degree that wool has. Silk approaches wool in absorptive power. Linen is next, cotton less, and imitation silk, of wood fibre, last in absorptive power. Silk resembles wool in giving up its absorbed moisture slowly, but linen and cotton give it up quickly, and cause the skin underneath to feel cool, because of the rapid evaporation. Because of this quality the latter materials are more comfortable in summer than either silk or wool of the same weight.

Absorptiveness is also influenced by weave to some extent. There is a limit beyond which materials can absorb no more. When this point is reached, the skin will inevitably feel damp, as it continues to produce some amount of perspiration. This stage is reached less soon in the case of wool clothing. After clothing has become damp from perspiration, it conducts heat away from the body faster, for damp air is a good conductor of heat. This is the reason that damp clothing, whether wet from without or from the body perspiration, leads to chilly feelings and to chilling and its consequences. The advantages of slow evaporation from woolen and silks may be counteracted by the long contact of damp air with the skin, since they dry so slowly. Ordinarily there is less danger of chilling from prolonged contact of slowly evaporating wet material than from short contact with rapidly evaporating wet material.

Because wool does hold moisture, it is not a suitable material to have next the skin if one is perspiring much. It becomes soiled very quickly with perspiration and sebum, does not dry out well, and if not frequently changed and cleansed gives out objectionable odors. Furthermore, bacterial growth is favored and the skin may be injured.

Mere thickness of material is not to be compared with loose texture and absorptiveness as a heat-conserving factor. A very thick puff filled with cotton conserves much less heat than a fluffy light wool blanket. After material is chosen for texture and absorptiveness, thickness may be considered.

Rather than one very thick layer, even of desirable material, two layers of similar material is better for warmth, because still more air will be contained between them. Merely thick material does, however, have the advantage that less cold air gets at the body to cool it. That one does not shiver under a thick cotton puff is due to this cause.

Another sort of material is that which contains no air spaces at all, yet conserves the body heat. These materials are warm in that they allow little cold to get at the body and little body heat to get out. They form a definite dividing line between the warm body and the cold air. But since they are non-absorptive, they allow perspiration to collect on the body. If they were sealed all about the body, nothing worse than great dampness underneath would result, but there are various openings through which some cold air gets in, and the general impression inside impervious garments is of being cold and "clammy."

Because the heat of the body is retained, and the moisture too, such garments may often be quite objectionable. This is particularly true of rubber coats. Very closely woven wool and leather give much the same results. Rubber garments are a good protection against wind and rain, especially if one is not exercising enough to cause much perspiration under them. If one is to be exercising, and in fact in any case, it is better to wear loosely woven wool under them to hold the moisture that they cannot absorb. Fur comes in the same category in so far as it prevents perspiration from evaporating under it. Its unusual warmth is due both to its being impervious in respect to the hide and air-containing in respect to the hair. When any impervious garment is worn, great care should be exercised when it is removed not to allow the accumulated moisture to evaporate too quickly.

Although in winter thick porous material holds the body heat imprisoned in its air spaces, in summer thin porous materials serve to allow any breeze that may be blowing to have access to the skin to drive away the surplus body heat. Porous material at all seasons is best.

Colors have some relation to the amount of heat conserved by clothing. Dark colors absorb more rays of the sun, as may

be shown by the degree to which snow melts under a dark or a light piece of cloth. Color is not of particular importance except in very hot days when one is much exposed to the sun.

The fit of clothing also bears some relation to warmth. Tight clothing impedes circulation and is thus colder in winter. Especially is this true in relation to shoes and gloves. In summer, tight-fitting garments prevent air from reaching the skin, and are warmer.

The cut of clothing also affects its warmth. That which covers the greater part of the body is necessarily warmer, but one may become habituated to having a smaller area covered without greatly upsetting temperature regulation, if one becomes accustomed to it—as, for example, the legs in recent styles. Those parts usually covered are susceptible to temperature changes if suddenly required to adapt to changing temperatures without training in so doing.

All of the foregoing factors should be borne in mind in dressing so as to keep warm in winter or cool in summer.

To keep warm, one should seek to retain the body heat by having several layers of material holding the air warmed by the body. A loose-meshed garment next the skin, such as silk or cotton jersey, may be the foundation. On the outside should be garments of loosely woven silk or wool. Between the two may be as many or as few layers as comfort or taste dictates. A dress and one undergarment does not meet the requirements in most climates. In going out-of-doors, a coat of thick wool in loose texture may be worn, or in suitable weather one of fur. Pure camel's hair wool is the lightest thick material. Some fur, as well as some woolen materials are objectionable because of weight. This point should be considered in clothing in which one is to be active. Thick materials of wool and cotton combined are too heavy to be practical.

Theoretically, when indoor temperature in winter is the same as ordinary summer temperature, no difference need be made in any of the clothing except the wrap for outdoors. Practically, because of the possibility of finding one's self in winter in an inadequately heated room, or in a draught, it is permissible for women to wear wool dresses, if there is no likelihood of becoming overheated. One should never wear

so much as to perspire indoors when sitting still. Either the clothing or the temperature of the room must be at fault if this happens.

Keeping cool is less of a problem than keeping warm, all that is necessary being the abandonment of everything not required for decency. Thin, absorbent underwear and loosely woven, thin outer garments of linen or cotton or silk, in light colors, are to be chosen for summer wear. Everything worn in the hot weather should be easily cleansable because of the increased amount of perspiration they must absorb. Dark colors, close weaves and wool are warmer. Women, as a rule, have less trouble than men in keeping cool. If a man really wishes to be cool, he should wear such materials as palm beach cloth, linen or pongee; loose-fitting knickerbockers in preference to the usual trousers; shirts with open collars and no coat or at least no waistcoat. Underwear should be practically the same the year around, seasonal variations in clothing being made on the outside and in respect to the number of layers worn.

The main characteristics of underwear should be the ability to absorb rapidly, evaporate not too rapidly, and hold air in its meshes. Underwear is for the purpose of absorbing the moisture that is always exuding from the skin. In so doing it aids in temperature regulation and protects the outer, less readily cleansed clothing from damage. Underwear is worn for these two purposes, and also to protect the skin itself from contact with materials that might injure it because of being irritating in texture or because of dyes or dirt.

Wool is not suitable for underwear because of its customary irritating qualities, and because it makes one too warm indoors. Infants and the aged and sometimes the feeble require wool or silk and wool underwear, but no well persons except those who practically live outdoors in cold climates. Silk is nearly as absorptive as wool. Next to it comes cotton jersey. Woven imitation silk, which is made of wood fibre, is to most people objectionably chilly in winter next to the skin.

Whatever the material of which underwear is made, if it is not frequently changed, it ceases to serve its purpose. After it has become saturated with moisture, it affects temperature

regulation adversely. It also affects the skin adversely. Moist underwear provides a good culture medium for bacteria, which may infect the skin. Silk underwear is itself damaged by the accumulated skin secretions and does not wear well unless changed very frequently. Airing the underwear at night is not a substitute for sending it to the laundry. It may become dry when so aired, but the chemicals from perspiration and sebum, the fatty material, epithelial scales, dust and dirt, and bacteria are not thereby removed. Any undergarment that has become damp should be laundered before being worn again. Whether it has become damp or not, it should be considered soiled much sooner than is often the case. The fastidious prefer to wear underclothing only one day. This is particularly true of stockings, that are the most prone to become saturated because covered with the impervious material of shoes.

Whatever sort of brassiere or corset or girdle is worn, it should not be worn next the skin, for the close texture of the material does not permit sufficient evaporation underneath. It will feel cold in winter and hot in summer. Furthermore, such garments as are not likely to be laundered daily become objectionable after they have absorbed a considerable amount of the body secretions. Whether warmth in winter or coolness in summer is sought, loose-fitting, porous garments next the skin are most suitable.

At all seasons of the year one of the main considerations is to wear clothing that favors evenness of body temperature and does not produce chilling. It is a problem that occurs at any degree of atmospheric temperature. Although more likely in the winter, one may become as dangerously chilled by sudden changes of temperature in summer.

Chilling consists of too marked a drop in internal temperature and is usually due to too rapid evaporation from the body. Since clothing is usually worn, the evaporation is usually from the clothing that has become damp, the result being the cooling of the surface of the body underneath, producing internal congestion.

The dampness of the clothing may result from too great body heat and the consequent perspiration, or it may come from

outside the body. Most people realize the danger of clothing that is wet by rain or snow, but fewer realize the danger of the dampness from perspiration. Getting too warm and damp indoors and then going out in the wind especially is hazardous. Going in and out from hot places to cold ones may produce chilling, however, even if perspiration has not taken place, by radiation from a hot although dry skin, especially if no exercise takes place when going into the cold.

Chilling may also take place by too long exposure to cold without enough clothing or exercise. While sitting still indoors in inadequate clothing with the room temperature at 65° F., one may get chilled. One should not wear so little clothing as to be exposed to this danger in rooms as they are ordinarily found. Those whose own homes are very warm may adapt their clothing to that temperature and be misclothed for ordinary temperature. In order to avoid chilling, the most important point is not to wear too much clothing, and the next is to wear enough. A very common but unwise habit is to leave the coat on while stopping indoors for a short time. It is as important to take coats off indoors as to put them on when going out. Usually they should be removed at once on coming into an ordinarily heated room, certainly before the body begins to get overwarm.

Outer garments of wool, even in summer, are desirable if there is any possibility of there being a marked change in temperature. They should not be worn unnecessarily at any season, however. Less than twenty-five years ago, the students at one of the prominent women's colleges were not permitted to leave the campus without hat, coat and gloves, no matter what the weather. This was not, of course, a health regulation.

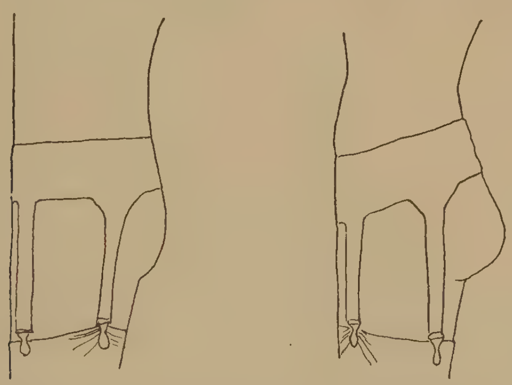
Formerly there was a custom of changing the weight of the clothing twice a year. In spring there came a time when the winter clothing gave place to the summer. It was put away in moth balls (because it was chiefly wool) and taken out again in the fall. At present no such abrupt seasonal changes are made, but clothing is adapted to the weather from day to day. The old idea has not entirely passed out, especially in respect to the wearing of fur coats. There are those who believe a fur

coat must be worn every day, regardless of weather, after it is first put on in the early winter. There are also those who think wool stockings must be worn continuously through the winter. If the changes from fur coats and wool stockings to lighter coats and stockings are made according to temperature and degree of exposure, rather than according to social or other needs, there is no harm in changing from one to the other. If, however, a costume demands silk hosiery and the temperature demands wool, it is better to wear wool with silk over them than to defy the temperature. There is, for most individuals, no necessity to wear wool stockings if silk or cotton ones are changed frequently, so that they shall never be damp; although those who take cold easily may gain added protection thus. Those who feel the need of wool but find it irritating may wear them over less irritating materials.

The greatest danger of chilling is perhaps associated with the wearing of fur coats and sweaters. Those who wear fur coats habitually need to use great care not to get too warm in them. One of the surest ways to catch cold is to wear a fur coat on a shopping expedition, going into hot stores with the coat on, getting moistly warm and then going out into the cold. The custom of wearing sweaters indoors is bad, in that one feels much too marked a change after a warm day in a sweater in putting on thin evening clothes, for example. This danger does not exist for men, whose evening clothes are scarcely thinner than their day clothes. Because their clothing is constantly somewhat warmer than is necessary, men frequently get overheated and would become as frequently chilled, if they were not so consistent in the amount worn. Such consistency is sometimes a danger, however.

Chilling of the body may result from local chilling of a small part of it. Parts of the body that are most susceptible to chilling on unexpected or extreme exposure are the feet, ankles and knees, and the neck and upper chest. Joints have less fat and fewer muscles about them, and the blood vessels are near the surface. In the main, those parts of the body that are always exposed are less susceptible to chilling, even if unduly exposed occasionally.

While clothing is performing its function of aiding in heat regulation, it should not be doing the body harm in other ways. It should not deform the body or change its shape, or cause displacement of organs by direct pressure or by causing poor posture. Nor should it interfere with the body functions, such as breathing and heart action, digestion or circulation. Clothing may interfere with posture by its shape, its weight or the pressure it brings to bear. It may cause fatigue by its own weight or by the hampering of activity by its constriction. There should be no limitation placed on the type of activity one is likely to engage in by the clothing worn at the time.



a *b*

Fig. 244.—Diagram to show the effect on posture of garters when properly adjusted (*a*); and improperly adjusted (*b*).

Finally, clothing should not cause irritation of any part of the body by pressing on it or rubbing against it.

Corsets as formerly worn were injurious in most of the respects mentioned. Even the bony structure of the body was changed by the pronounced constriction of the corset. As at present worn, they usually fit snugly over the hips only, and bring no undesirable pressure to bear there. They may, however, be worn in such a way as to press downward on the abdominal organs. No corset should be worn that has not been properly fitted to the individual who is to wear it. Thereafter it should be put on preferably while lying down,

so that the abdominal organs may take their normal position. After so adjusted around the hips and lower abdomen, it should leave the waist and chest free to expand in breathing movements. The best sort of corset or girdle hardly extends above the waist. Those made entirely of elastic, and without lacings, are suitable if they are put on properly and held down in position by garters. The garters should exert their chief downward pull at the sides and back, rather than in front. If they pull downward in front, they tend to increase the lumbar curve of the back.

Fig. 245.—Illustrating varicose veins.

Corsets or girdles are sometimes desirable to correct a tendency to a sagging abdomen. But at the same time efforts should be made to strengthen the abdominal and lumbar muscles to do their work unaided.

Some sort of corset or girdle is needed if skirts are worn, to prevent them from pulling downward, unless they are hung on a waist lining. Bands about the waist should not be worn at all. Even the elastic in knickers should be very loose. Belts to hold trousers in place do no harm if they rest on the hips. They cannot usually be worn thus without creating a gap between waistcoat and trousers, hence braces or suspenders are called for except when no waistcoat is worn.

The problem of keeping the stockings up without constricting the legs is difficult if no corset is worn. There are several types of underwear, however, from which garters are suspended that bring no pressure to bear except on the hips. If nothing of this sort is worn, an elastic belt, fitting about the hips and not at the waist, with several pairs of garters attached, may be worn.

Narrow bands of elastic about the legs are undesirable because they interfere with the return of venous blood and lymph from the parts below. If there is any tendency to varicose veins, such bands should be particularly avoided.

Rolling the stockings is less injurious to circulation than circular garters, because the pressure need not be so tight as that of garters. Rolling the stockings from the top down over a rather loose elastic band or spiral wire garter gives adequate support with only moderate constriction. Men's garters are not injurious if they are properly adjusted, especially if made of the wider elastic.

Brassieres are the most constricting garments worn at the present time by women. Although they may be aesthetically desirable for those who are overweight, they may be physiologically harmful. They should not be worn so tight as to prevent full expansion of the lungs, or to injure the particularly susceptible breast tissue. In putting them on, the breasts should not be pulled downward, so that they become pendulous. The slight confining effect should be entirely in the direction of the chest wall, not downward. The use of any strapping of the breasts is absolutely to be condemned.

The clothing of men is objectionable, often, in respect to collars and hats. Stiff, tight collars interfere with cerebral circulation and may be responsible for headaches. There should be nothing worn that must be loosened in an emergency in order to permit the body to function as usual. Stiff collars that are tight may also rub against the skin of the neck and cause irritation or boils. A large proportion of all boils occur on the back of men's necks. They are more common there than in any other single location. If stiff collars are loose enough and low enough, they are as satisfactory as soft ones. Theoretically, men need collars no more than women do.

Hats are largely a matter of habit. They should be worn when the wind is cold and sharp, when the hair is likely to get wet and remain so, and in summer to protect the hair against very strong, prolonged sunlight. Hats are also desirable when much dust is in the air, unless the hair is to be washed frequently. On the other hand, hats that are too tight may cause enough cerebral congestion to cause a headache. It has been asserted that the close-fitting hats of men are responsible for the tendency of men to get bald. Possibly they may have some such effect in limiting the growth of the hair in women also. Certainly if worn on a warm day, an unhealthy degree of

moisture may be produced under a very tight-fitting hat. Those who are subject to head colds should beware of exposure of the head that makes it feel chilly.

The cleanliness of clothing should be considered not only in relation to decency but in relation to health. One of the advantages of light-colored clothing is that it "shows the dirt." The opposite argument is often erroneously used as a recommendation for dark clothing. All possible garments should be washable, and the others cleansable. It cannot be estimated how much bacterial infection or how much skin irritation is due to soiled clothing, but it is probable that it is in proportion to the offensiveness of such garments to the olfactory sense. The dry cleansing of garments is worth paying for, both on the grounds of health and decency and because of the fact that the materials themselves wear better if kept free from dirt.

The psychological aspects of clothing are as important to mental health as the physiological ones are to bodily health. There are emotional reasons for the choice of clothing, and, in turn, the clothing worn influences to some degree the emotional life. Although not consciously present in the mind, there is probably always in the background, in getting clothes, the question of how well the clothes will represent the ego. Those to whom this question is conscious are usually the ones who are most successful in declaring their own personality thus. They may choose their clothes as an actor does the costumes to be worn in playing a part, to represent what they really are or what they wish to seem.

Nevertheless the entirely unconscious choice of clothing may as definitely represent the character. For example, those who unconsciously feel themselves inferior often strive equally unconsciously by their clothing, that fairly shouts for recognition, to get the attention they cannot get otherwise. The clothing may be no more blatant, however, than the individual's manners. Inferiority feelings often lead to slavish following of style, and an unwillingness to appear without expensive clothing that is in every detail exactly what "they" wear on given occasions. Such lack of self-confidence will usually show itself in other ways and be generally hampering, unless it is recognized and overcome. The opposite state of

mind, complete disregard of dress, does not always, however, indicate an individual of great self-reliance. It may mean merely a defiance of social demands, that will also be found exhibited in other ways, and be responsible also for other, more serious lack of conformity.

It is impossible to determine what lies behind the choice of clothes. Great care should be used in concluding that a certain character is to be found associated with certain kinds of clothes. For one reason or another, clothing may not be at all self-expressive. It is not even certain, for example, that a disorderly mind will be found in disorderly clothing, or that a vain person will be found in ornate clothing, or one interested in sex in so-called "suggestive" clothing. The reasons behind the choice of clothes may be quite other than they appear. It is worth bearing in mind, however, that society commonly does so judge an individual by his clothing.

The well-adapted individual does not scoff at clothing, but, recognizing its psychological effect on himself and others, gives it enough but not undue attention—as a result, finding some support for his ego in being clad in a manner representative of himself and his rôle in life; satisfying his herd instinct by being comfortably in conformity with custom; getting some aesthetic pleasure for himself; and, by making his appearance as agreeable as possible, at least avoiding giving offense to others.

CHAPTER XXXVII

BATHING

There is a common saying that "cleanliness is next to godliness." It seems so to have been considered in many parts of the world and among many peoples. Throughout history, in most religions bathing has had a place as a sacred rite. The Oriental religions, developed in hot climates, seem particularly to have incorporated bathing into their religious ceremonies. In some religions, bathing is required before prayer. The Koran and the Hebrew scriptures refer, with the greatest respect, to cleanliness. The rules regarding bathing are spoken of as having come from Allah or Jehovah. The Romans bathed before entering the temple. In Normandy the dead were bathed in order to purify the soul before its departure from the body. The fact that running water has been so frequently referred to as a necessary part of the rite of bathing seems to indicate that some observations of its health significance must have been made.

The visitor to Rome is impressed with the significance of bathing at the time of Rome's preëminence. The gorgeous public baths, in fact, represented one of the first public health measures ever adopted. But the cost of their upkeep was so great that they ultimately became luxuries in which only the nobles were able to indulge. To them, however, bathing was the height of luxury.

The practice of bathing declined among the early Christians who looked upon so much care of the body as detrimental to the soul, and upon so much indulgence in luxury as sacrilegious. Michelet in speaking of the Middle Ages lamented the "thousand years without a bath."

Whatever the reasons for bathing, and there are many, the custom is so fully established now that it is hard to realize that

there have been times in the history of the world when such was not the case. At present, as somebody has said, the point of view is that "If cleanliness is half a virture, uncleanliness is a vice and a half." Certainly from the health point of view this is true.

It took long for the bath to return to favor in the Christian world. When the world first awoke after the long sleep of the Dark Ages, bathing began again, not among the general population, but in the courts of the kings. The court beauties were the first to revive bathing, because of their observation of the relationship between cleanliness and beauty. They recalled the allegory of Venus, the goddess of beauty, rising from the waters. There is some indication that it was at first considered a somewhat feminine practice. Nevertheless the practice grew. A great impetus to bathing was given by the invention of soap at Savona in Italy. Much experimentation was done regarding the materials to aid in cleanliness.

Isabeau of Bavaria, one of the celebrated beauties, exactly copied the method of bathing used by Poppaea, the wife of Nero. She bathed daily in a marble bath which was a great curiosity in her time. But she did not bathe in water, but in asses' milk, or in a decoction of strawberry juice. Women of less lofty rank copied her custom, but collected rain water for the bath. If they were unusually daring, they jumped into a stream, as did Diana of Poitiers, who became noted for her bathing. Some chose cows' milk, or buttermilk, or barley juice, or almond water. A favorite of Alexander I of Russia always bathed in Malaga wine, which was afterward bottled and sold to the admiring public. The peculiar whim of Anne Boleyn, to bathe her beautiful self occasionally, may have had something to do with her downfall, for her courtiers are said to have aroused the jealousy of Henry VIII by demanding to fill their glasses from her bath in order to drink her health.

Court physicians were sometimes called on to prescribe special baths for the health of their sovereigns. The chief physician of Louis XIV of France believed that baths should be taken cold in winter and warm in summer, in order to cause the temperature of the body to be more nearly like that of the atmosphere.

There are now many reasons for bathing other than those of health and beauty, although these perhaps underlie them all. Former President M. Carey Thomas of Bryn Mawr, in an opening address to students once said, "In our generation a great gulf is fixed that no democracy or socialistic theories can bridge between men and women that take a bath every day and men and women that do not." Bathing has become a symbol of self-respect and of a taste for fine and clean things. It is even a question whether it is not more important for these other reasons than for health. Men who have been in the Arctic report that in that climate the same clothing may be worn for months without apparent damage to health. For social and aesthetic reasons it would not be desirable to make such an experiment in warmer climates. There is a minimum of bathing needed for health, but much more is needed for the maintenance of self-respect and the respect of others.

There is an instinct for cleanliness observable even in animals, that lick and preen themselves and go into the water when possible. The human young are like some few animals, however, in apparently more often disliking water. Often the instinct for cleanliness does not appear until adolescence. It does develop in time in all those who are entirely normal. Those with mental disease often show it first or prominently in personal uncleanliness. Questions regarding this matter are always asked by psychiatrists examining those suspected of certain common forms of mental disease.

Although bathing is still looked upon by some individuals as either harmful or "weakening" or a needless luxury, it is with most people almost a sacred rite. A house intended for a whole family and containing only one bath would be rather unsaleable today. The Englishman and his tub is a matter of universal comment, as is the American and his tiled bathrooms. The Japanese, however, excel all others in bathing, in that they bathe and change their clothing before ever sitting down to eat. It is reported that even the Japanese workman does this.

Much of our bathing is done for other reasons than health. Very few do their bathing with the effect on health in mind, although this is a rational ground for determining both the sort

of baths taken, and their frequency. In choosing the kind of bath to be taken for health purposes, one must consider its effect on cleanliness, circulation, the nervous system and temperature regulation. Only one of these points is commonly considered—cleanliness. Yet the others are equally important.

In order to be clean it is necessary to get rid of the accumulation of debris composed of shed epithelial cells, products of the sebaceous and perspiratory glands, and dirt from the outside. This debris forms a good breeding place for bacteria, and irritation or infection of the skin may follow. It is kept partly removed by friction of the clothing, but it is better to dissolve it off in water or soap and water. Although the rubbing of clothing removes some of it, it does not take it entirely away unless the clothing is changed daily. Instead, the clothing rubs it back into the skin, which makes matters worse. This is shown by the prevalence of irritation and infection where rubbing of soiled clothing is most pronounced—on the back of the neck and upper chest and on the arms. Unclean wool dresses are the worst offenders.

Cleanliness of the skin is also necessary to keep the mouths of the ducts open, and the dead epithelium at a minimum in order that the skin may function freely—that is, to permit its use as a temperature-regulating mechanism, and as an organ for receiving the sensory stimuli that are so important a part of a general sense of well-being. It is probable that the latter result of bathing is one of the main reasons why bathing is popular—that it permits a large number of pleasant skin sensations of which one is only vaguely but unmistakably conscious.

Cleanliness to avoid unsightliness and odors need hardly be mentioned. Soap and water should be used daily on the parts of the body that get the most soiled—especially on the face and hands, and the corners where secretions tend to accumulate.

The aim is to remove everything on top of the epidermis and a little of the epidermis also—that portion of it which comes off easily in the ordinary way of bathing. A great deal more epidermis may be removed by special methods, but it is not desirable to get too near the true skin.

The layman often believes that bathing is to remove body wastes. This is an erroneous idea. An infinitesimal amount of waste is so gotten rid of, the waste being largely removed by other organs. When it is urged that the skin be kept active, it is because it gets rid of water and thus to some degree saves the work of the kidney in respect to water elimination only.

The effect of bathing on circulation, the nervous system and temperature regulation, depends on the kind of bath.

Baths may be classified as hot, tepid or cold; or as tub, sponge, shower or plunge; or as general or local (of any part of the body). They may also be classified as mainly for cleansing purposes; mainly for stimulation of the circulation or the nervous system; mainly as a sedative of the circulation or the nervous system; or mainly to affect body temperature.

The cold bath is one at a temperature below 65° F. It is taken largely for the activation of the circulation. Whatever cold temperature produces this result is a cold bath. It is not necessary to have it as cold as ice water. As somebody has truly said, "The proof of the bath is in the bather." The effect of a cold bath should be, first, a constriction of the surface blood vessels, accompanied by a gasp at the shock of the cold. The blood is quickly driven to the interior of the body, and the muscles automatically contract. This is normally followed by a quick return of the blood to the surface, where it should find not more cold water, but a coarse towel being vigorously rubbed over the body. This involves more muscle exercise. At this time the skin should be in a glow, the respirations full and deep, and the body should feel warm and ready for action. The mind should feel fully awake. The total result is a great increase in circulation, a great stimulation of the nervous system, and an increase in heat production because of the involuntary and voluntary contraction of muscles. It stimulates metabolism and heat production as exercise does, and is thus more properly classed with exercise than with bathing, although it is also cleansing in its effect.

The effect of the cold bath on the actual temperature of the body is usually neither that of lowering nor raising it. This is because the initial cooling of the body by the abstraction of heat from the surface is offset by the increase of temperature

that results from increased metabolism. If friction is used in drying the body, there will be no fall of body temperature. Without friction, if the bath is prolonged, the temperature may be reduced, especially if it is already higher than usual. Cool sponging is sometimes used to lower high fevers. Ordinarily, a long cool or cold bath is not desirable. It can hardly be too cold if it is sufficiently short and followed by vigorous rubbing.

However, a temperature must be chosen that for the individual produces the results mentioned. If the reaction does not come as described, the bath is not beneficial. A cold bath should not be a duty but a delight. If it is not a delight, one may vary the temperature and the procedure before abandoning it entirely. But many of those who religiously take cold baths are undoubtedly harmed by them—for example, the high-strung, overstimulated individual. On the other hand, the fat and sluggish, who would be most benefitted by it, usually hate it. The cold bath should not be taken if, when taken properly (i.e. quickly), the subsequent rubbing does not warm one up. There is no virtue in feeling cold and shivery and looking pinched and blue. The proper reaction may not come when one begins taking cold baths, which may be because one's technique is not good. This is particularly true if they are begun in the winter. Summer is the best time to begin, continuing through the winter.

The best time to take a cold bath is in the morning, because it wakes one up at that time, and gets one ready to work. Such wakefulness would not be desirable at night. A cold bath is also desirable following a hot one, if one must go out immediately after it, in order to prevent chilling. It is also desirable after a hot bath following exercise. It aids the circulation to get rid of fatigue toxins and prevents lameness. Unless the cooling of the water in either case is quite sudden, the desirable reaction may not come. It is not a successful procedure to remain in a hot tub while the water is gradually cooled. A cold bath should never be taken when one is already cold. A cold bath in a cold bathroom need not be warned against, for only the fanatic would consider it.

The cold bath in the morning is a desirable preliminary to breakfast, which may safely follow it after the interval required

for dressing. The increase of circulation aids the secretion of the digestive glands. Appetite, digestion and elimination are usually greatly improved if the reaction to the bath has been good.

Because of the stimulation of metabolism by the increased circulation and muscle action, cold bathing is desirable for those who wish to reduce. In such a case the rubbing should be longer and harder.

A considerable part of the value of the cold bath is in the improved tone of the muscles, and of the small arteries in the skin. As an aid to successful temperature regulation both of these factors are very important. Cold bathing tends to make the individual less susceptible to drafts and chilling, and hence to colds, because the arterioles have practice in adapting to marked changes of temperature.

It does not matter whether the cold bath is a quick plunge into a tub, or under a shower or spray. The volume of the water in the tub and the force of the water from the shower or spray produce much the same results. The sponge bath, unless very quick, is a more chilly procedure than either. For the beginner a quick cold sponge or splash on parts of the body such as the chest, may serve to give him quite a reaction and enable him gradually to increase the area so bathed. If necessity limits one to the sponge bath, it is better to bathe the body in sections, rubbing each section until the reaction is obtained before the next is bathed.

A cool bath is one between 65° and 80° F.; a tepid one between 80° and 90° F.; a warm one at body temperature; and a hot one appreciably above body temperature. A hot bath should never be so hot as to require getting into it cautiously, or hot enough to affect the heart and breathing when one enters or leaves it. The suspicion that hot baths are "weakening" is well founded. If they are too hot, they cause anemia of the internal organs, even of the brain. Fainting or heart failure may result. A daily hot bath is not compatible with the best health. This practice may be all that keeps some individuals from the enjoyment of their full energy. If taken at night, a hot bath is likely to cause wakefulness. By disturbing the heat regulating mechanism it may increase

susceptibility to cold. Hot baths are often mistakenly taken for reducing purposes; but they decrease metabolism, and on this account would tend to cause an individual not to lose weight, unless the perspiration following them is excessive.

The daily warm bath is, however, satisfactory. Soap should not be used on each occasion, for it tends to dry the skin too much and hence to irritate it. There are individuals whose skins are unpleasantly affected by the daily use of warm water alone.

The effect of the warm bath is to bring more blood to the skin, where it gets warmed if the water is above body temperature. This tends to raise body temperature, especially if no perspiration occurs. But the warm bath also reduces metabolism, which tends to lower body temperature. The two effects usually balance each other. If perspiration occurs after it, there may be slight lowering of body temperature. If the bath is prolonged, the factors that raise temperature usually predominate. A short warm bath at the beginning of a fever, when one feels chilly, sometimes is helpful for the relief of internal congestion, which it accomplishes by drawing a good deal of blood to the surface. But such a procedure should always be followed by going to bed without the slightest delay and staying there, so that one may not suffer further chilling by exposure when warm.

The warm bath is taken chiefly for cleansing purposes, but it is also useful as a sedative to the nerves after a tiring day. When used for this effect, no rubbing should follow, but merely patting of the skin to dry it. The warm bath should last as long as fifteen or twenty minutes, in order to get the full sedative effect, although it need not ordinarily be so prolonged. Muscles are also relaxed and helped to get rid of their fatigue products by the warm bath. For this purpose brisk rubbing after it is desirable. Warm baths need not be omitted during menstruation.

Turkish baths are used by some because of the profuse perspiration they cause. As a rule, they should be used only under medical advice, although there is less danger in their occasional use than in bathing in a tub of steaming water at home every day.

The dry rub is recommended in the morning for those who do not stand cold water well. Five minutes of rubbing gives considerable exercise of the muscles, and stimulates the circulation to a profitable degree. Those who need to reduce may add to their metabolism in this way. If the skin looks or feels irritated the procedure should be modified, however.

The daily regimen of bathing should include warm water and soap for the most soiled parts of the body, and an all-over bath without soap, preferably cold if taken in the morning and warm if taken at night. About twice a week there should be a complete warm bath with soap. There is little to choose between tubs and showers. The advantage of the shower is that it is quicker to prepare and is not so likely to be prolonged. It is also cleaner, although the tub may be kept as clean as need be if each user of it washes and dries it after using it.

Bath cloths and sponges should not be used unless washed and dried between each using. They may otherwise harbor bacteria which, in rubbing, will be implanted in the skin. This is particularly likely to be true of cloths used on the face.

After the bath is the best time to use the orange stick on the nails of the fingers and toes. The cuticle should be gently pushed back on both sets of nails. Thickened skin on the feet may be rubbed down to a considerable degree after the bath. Even pumice may be used, with care to avoid injury. Calluses should be prevented, however, by preventing the shoe pressure that usually causes them.

The discovery of soap was one of the most important of the simple discoveries. Since it was first made it has been in standard use the world over. Rosenau has commented on the fact that the amount of soap a nation uses is an index of its degree of civilization. No other single article can compare with soap in respect to the amount of sickness and death prevented by its use. Epidemics rage where little soap and water are used for personal and domestic purposes. Uncleanliness of habits of living may be considered responsible for more ill health than any other one cause. Bathing is, of course, only one of the ways in which uncleanliness is combatted, and supplies only one field for the use of soap.

There is some popular solicitude about the kind of soap to be used. Physicians usually state that "any pure soap" may be used. Perhaps it is better to be more explicit and say that any soap made by a reliable manufacturer is likely to be pure; but that soaps bearing no name may be products their manufacturer is not proud to claim. Many impure soaps are highly scented and colored, although these qualities do not necessarily signify impurity.

Within the limits of purity soap may vary in its suitability for use on the skin. This is because of the varying proportions of alkali found in it. Soap is made by combining alkali and fat. Those intended for laundry purposes have more alkali, are more cleansing to clothing and more injurious to the skin. The alkali must be at the minimum in toilet soap, or it will dissolve too much sebum and irritate and roughen the skin. Sometimes enlarged papillæ on arms and legs are due to too much washing with this kind of soap, rather than to too little washing. The excessive use even of soap that does not contain too much alkali may dissolve too much sebum.

Aside from absence of excess alkali, the only other necessary quality in soap is free lathering, which enables much soap to be put to work quickly. Cocoanut oil soaps lather most freely and may be made to do so even in hard water and salt water. Superfatted soaps are those in which the proportion of fat to alkali is greater than usual. They may be profitably used if the skin tends to be very dry. Transparent soaps contain glycerine, which affects some skins favorably and others unfavorably.

The medication of soap is not very successful. No soap is much more curative of skin disease than any other. Furthermore, no soap is much more disinfectant than any other. They cannot contain enough disinfectant chemicals to make a sufficiently powerful solution in water. It would be necessary for them to be very powerful to accomplish any results in the short time they are left on the skin. The removal of dirt is about all that can be expected, and that is a great deal. The advantage of medicated soap is that it encourages the use of soap itself. If one thinks it has powerful properties,

more of it is likely to be used. Those bearing the odor of disinfectants are widely used—which is a good thing.

Since soap itself is not germicidal, the bacteria that get on it may remain alive. It is therefore imperative to use only one's individual soap, or that from a container of liquid or powdered soap.

All soap should be thoroughly rinsed off the body. Chapped skin in winter, especially of the face and hands, is usually due to incomplete rinsing. Various sorts of defects in skin texture may be due to soap left on the skin.

Sea bathing and lake and river bathing are not only pleasant because of the sport, but they are also, partly unconsciously, pleasant because of the stimulating effect of the moving air and moving water on the nerves of the skin. In salt water the salt has something to do with this effect, but that it does not produce it alone may be proved by using salt in the bath tub. Often the salt in the sea water is thought to be the particularly invigorating aspect of it, but this is not so. Fresh water, if it is cold, has much the same effect, especially if there is a breeze blowing.

The hygiene of sea bathing (or bathing in any body of water) involves not staying in the water too long, and keeping in motion while in it. It is usually recommended that one should not bathe just before or after meals, although some professional swimmers disregard this point, apparently without much harm. It is usually advisable not to go in while perspiring very freely, but this may be no worse than going in when already chilly. Probably the effect of the swimming exercise is enough to counteract either condition. The plunge that makes one blue and cold is not beneficial. If such a state arises, one should leave the water, and rub briskly until warm. Further experiments may be made to see whether this effect is going to be customary, even with a short stay in the water. If an individual swims vigorously and still remains blue in the water, either the water is too cold or the condition of the circulation not satisfactory.

It is usually not desirable to remain in the water much more than half an hour. If the sun is hot and one dries off quickly, it is beneficial to lie about or play about on the sand. If the

skin burns easily, it is preferable to wash off the salt before much exposure to the sun. On a cool damp day without sun, it would be better to get dressed at once. Two plunges a day seem to be within reasonable limits, although even more may do no harm. Ordinarily it is not desirable to go in bathing during the menstrual period, although no particular harm would probably result if the individual did not get chilled, in which case rather serious results might follow.

Those who have chronic middle ear disease or sinus disease should not get water into the nose or ears. If one has ever had such difficulty, it is necessary to get medical advice before running the risk of starting up the trouble anew. Even an ordinary cold may be made worse by the exposure, and by the water in the nose.

Swimming pools are either safe or not, according as the water is sterilized and according to the behavior of those who use it. Chlorine is the most common disinfectant used in pools. This may have a somewhat irritating effect on the mucous membranes, but does not injure them in the percentage usually used. No means of disinfection of the water keeps it clean unless the bathers carefully avoid contaminating it in any way. It is customary to require of bathers in pools a given technique of preparation for its use, and to exclude all those having any infection.

CHAPTER XXXVIII

VENTILATION

It so happens, not by chance, that man is most active in the temperate climates. In such climates a good deal of his time must be spent indoors in order to carry on his work in comfort. The ventilation problem arises because of the effort to live indoors without the sacrifice of the benefits of fresh air. These benefits are very real ones.

Wherever individuals are observed whose work permits them to be outdoors more than usual, they seem almost invariably to average better in health than indoor workers. The fact that they must be more physically active, in order to work outdoors during all seasons, partly accounts for their better condition. Since the indoor worker is usually also a sedentary worker, it is somewhat hard to determine to what degree the fresh air itself is responsible for the better health of the outdoor worker.

It is believed that the fresh air itself is the most significant factor, for similar activity indoors usually fails to keep him in the same state of health. Moreover, invalids who are outdoors but not active gain in health and do better than do closely housed invalids. This is plainly seen in the case of the tuberculous. It is also seen in the case of babies who are put outdoors for their naps. It is further confirmed in the case of adults who sleep in an abundance of fresh air. The health advantages of fresh air are not questioned. It is necessary to sleep in a closed room only a single night to observe certain changes in the sense of well-being that stuffy air produces by itself, with all other conditions identical. The same changes may be observed in one's feelings after sitting or working in a room where the air is definitely to be described as "bad," "stale," "stuffy," "not fresh."

Individuals do not agree in describing any given air as "bad," but even the least susceptible and least observing occasionally find themselves in air which must be so described. Such air produces a certain train of symptoms. Lassitude, fatigue, drowsiness, and a disinclination to do physical or mental work are prominent symptoms which each individual has experienced at some time or other, and has attributed to bad air. Headache, nausea, even fainting, may follow; or, in some, motor and mental restlessness.

The air that produces such symptoms is usually that which prevails in a crowded room, unless it is well ventilated. The observing individual detects odors, and might be inclined to think that poisons were given off in the breath of those in the room, and that these were responsible for the symptoms. Scientists have, however, investigated the question of poisons in expired air and have concluded that there are none that could possibly cause the unpleasant symptoms except as they affect the sense of smell. Organic poisons from foul mouths, infected gums, decayed teeth and fermenting digestive tract are given off in the expired air, as well as body odors of other sorts. These do not poison, however, but cause a disagreeable stimulation of the olfactory nerve, and a psychic effect through their association with filth, which may make one feel ill. They are not responsible for all the symptoms of "crowd" poisoning, or for any real poisoning at all.

Since the odors are present when ventilation is inadequate, it may more logically be concluded that most of the symptoms are due to the total result of lack of ventilation rather than to its failure only to remove odors. The degree to which odors are removed may, however, be considered one of the indices of adequate ventilation. If, upon coming into a room from outside, the nose gives unfavorable information, it may be concluded that the air is bad, even though the odors themselves do not constitute the injurious factors. If one is fortunate in being sufficiently susceptible to unpleasant odors, one has a natural warning against remaining in poorly ventilated places. Unfortunately the olfactory nerve tires easily, and after being in a badly ventilated room even a short time one ceases to be aware of its odor. If the air is good at one's entry into the

room, it is even possible that one will not notice the change in odor if it becomes bad later.

Parallel to the investigation of organic poisons in the air that collects where there are crowds, was carried on an investigation based on the knowledge of the chemical qualities of the air in respect to oxygen and carbon dioxide. It has long been known that oxygen is reduced and carbon dioxide increased in expired air. Very naturally, for many years it was thought that bad air was air in which carbon dioxide was increased, especially since no other poison could be incriminated.

Carbon dioxide is known to be a poison in large doses, or in high concentration. It was thought that even small increases in carbon dioxide probably were to some degree poisonous, and produced the well-recognized symptoms of bad air. In a room in which there are many persons, the carbon dioxide may increase to a considerable extent. Standards were therefore set for the chemical quality of the air. It was agreed that oxygen is seldom reduced below a satisfactory level—never in natural conditions. But since an excess of carbon dioxide was considered poisonous, it was decided that carbon dioxide should be kept from accumulating beyond .06 per cent; and that ventilation should have this low point of carbon dioxide as its aim. Then it was discovered that the amount of carbon dioxide might under certain circumstances be as high as one per cent without producing any symptoms.

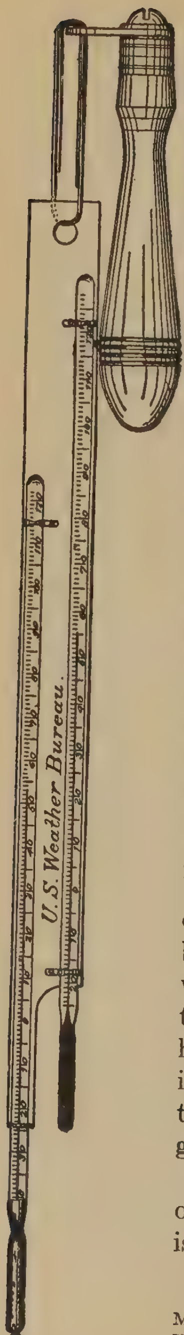
It began to be suspected that some qualities other than carbon dioxide in the air that gathers where there are crowds might be responsible for the symptoms that arise. The fact was recalled that expired air is warmer and more moist than inspired air, as well as having a higher percentage of carbon dioxide. Attention was drawn to the fact that additional warmth and moisture are given off not only in the expired breath, but also from the body generally.

Experiments were then made to determine to what degree the warmth and the moisture of the air might be responsible for air being called bad, and for the symptoms produced by air so described. These experiments involved the use of hypothetically good air (i.e. not moist and warm) about the body and entering directly into the lungs, as compared with the

opposite sort of air used in the same way; and the use in the same ways of what had previously been considered bad air (i.e. high carbon dioxide content) as compared with what had been considered good air (i.e. low carbon dioxide content).

A subject was confined in a room in which the air was allowed to get very "bad." The air, as usual when it is bad, showed a high percentage of carbon dioxide. The subject was kept in such air until he felt the usual symptoms. Fresh air from outside was then piped directly to his nostrils, so that while surrounded by bad air he was breathing fresh air. No relief came to him. Then air of exactly the same temperature and humidity as that in the room, but with the correct amount of carbon dioxide and oxygen, was allowed to enter into his room. Still he felt no more comfortable. Then an electric fan was started in the "bad air." Immediately he felt better. Finally, air with low oxygen and high carbon dioxide, but of low temperature and humidity, was turned into the room. The man immediately experienced great relief, although the carbon dioxide and oxygen ratio had not been improved. The conclusion was that air that was cool and moving and not too moist was what he needed, rather than air containing an increased amount of oxygen and a decreased amount of carbon dioxide.

In order to confirm these conclusions, more experiments were done. The man was placed in fresh air, outside the room containing bad air, and the bad air was piped to him for him to breathe. So long as his body was in good air he was able to breathe the air containing less oxygen and more carbon dioxide without feeling any effects of it. The final conclusion, that has been confirmed repeatedly, is that air seems "bad" and gives symptoms of discomfort for reasons quite apart from the *chemical* composition of air that is breathed in, but in direct ratio to the *physical* qualities of the air that surrounds the whole body. The term "good" air has reference, thus, more particularly to the air that surrounds one than to the air one breathes. If bad air may be sufficiently dried, set moving, and cooled, symptoms disappear, desire for work returns, and without knowing why, perhaps, one concludes that the air is "good." Although bad air is found chiefly in



crowded places where many persons are adding warmth and moisture to the air, it may also be found in a room where only one person is, if the space is so small as to be readily filled with these undesirable qualities and no provision is made for ventilation.

Ventilation, therefore, means the removal of excess moisture and heat by the introduction of new air which produces currents. A well-ventilated room is one in which the temperature is not too high, the moisture not in excess, nor the air too still.

Examination of the air for these qualities involves, first, the estimation of temperature, which is simply done by the thermometer. It should be taken at the working level, not too near a hot radiator nor a window. The comfort zone indoors is found to be about 65° to 70° F., providing the humidity is at the correct level. If the temperature indoors is much above this, the body temperature rises a little, unless some of the surplus heat is at once given off from the body. Probably a good deal of the discomfort in bad air is due to a slight rise of temperature. The drowsiness may well be due to the removal of blood from the brain when it goes to the skin, in order to help cool the body by evaporation of fluid there. If a temperature of 65° to 70° F. seems too cold, it is usually because the humidity is too low; if it seems too warm, the humidity is probably too high, as is the case in crowds. Public meeting places have lower temperature standards than dwellings, because of the increase in them of both temperature and moisture as soon as people gather in them.

Humidity is determined by several sorts of instruments. The wet bulb thermometer is used as a guide to the regulation of mois-

Fig. 246.—Sling psychrometer. (From Rosenau, "Preventive Medicine and Hygiene." Courtesy of D. Appleton & Co., New York, Publishers.)

RELATIVE HUMIDITY TABLE

Air Temperatures	Difference Between the Dry and Wet Thermometers																														Air Temperatures
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
30	100	89	78	67	57	47	36	26	17	7																						30
35	100	91	82	73	65	54	45	37	28	19	12	3																				35
40	100	92	84	76	68	60	53	45	38	30	22	16	8	1																		40
45	100	92	85	78	71	64	58	51	44	38	32	25	19	13	7	1																45
50	100	93	87	80	74	67	61	55	50	44	38	33	27	22	16	11	6	1														50
55	100	94	88	82	76	70	65	59	54	49	43	39	34	29	24	19	16	10	6	1												55
60	100	94	89	84	78	73	68	63	58	53	48	44	39	34	30	26	22	18	14	10	6	2										60
65	100	95	90	85	80	75	70	65	61	56	52	48	44	39	35	31	28	24	20	17	13	10	6	3								65
70	100	95	90	86	81	77	72	68	64	60	55	52	48	44	40	36	33	29	26	23	19	16	13	10	7	4	1					70
75	100	95	91	87	82	78	74	70	66	62	58	55	51	47	44	40	37	34	31	27	24	21	19	16	13	10	7	5	2			75
80	100	96	92	87	83	79	75	72	68	64	61	57	54	51	47	44	41	38	35	32	29	26	23	20	18	15	13	10	8	6	3	80
85	100	96	92	88	84	80	77	73	70	66	63	60	56	53	50	47	44	41	38	36	33	30	28	25	22	20	17	15	13	11	9	85
90	100	96	92	88	85	81	78	75	71	68	65	62	59	56	53	50	47	44	41	39	36	34	32	29	26	24	22	20	17	15	13	90
95	100	96	93	89	86	82	79	76	72	69	66	63	60	58	55	52	49	47	44	42	39	37	35	32	30	28	25	23	21	19	17	95
100	100	97	93	90	86	83	80	77	74	71	68	65	62	59	57	54	51	49	47	44	42	39	37	35	33	31	29	27	25	23	21	100
105	100	97	93	90	87	84	81	78	75	72	69	66	64	61	58	56	53	51	49	46	44	42	40	38	35	33	31	30	28	26	24	105
110	100	97	94	90	87	84	81	78	76	73	70	67	65	62	60	57	55	53	50	48	46	44	42	40	38	36	34	32	30	28	27	110
115	100	97	94	91	88	85	82	79	76	74	71	69	66	64	61	59	57	54	52	50	48	46	44	42	40	38	36	34	33	31	29	115
120	100	97	94	91	88	85	83	80	77	75	72	70	67	65	62	60	58	56	54	51	49	47	45	44	42	40	38	36	35	33	31	120
125	100	97	94	91	88	86	83	80	78	75	73	70	68	66	64	62	59	57	55	53	51	49	47	45	43	42	40	38	37	35	33	125
130	100	97	94	91	89	86	83	81	78	76	74	71	69	67	65	62	60	58	56	54	52	50	49	47	45	43	42	40	38	37	35	130
135	100	97	94	92	89	86	84	81	79	77	74	72	70	68	65	63	61	59	57	55	53	51	50	48	46	45	43	41	40	38	37	135
140	100	97	95	92	89	87	84	82	79	77	75	73	71	68	66	64	62	60	58	56	55	53	51	49	48	46	44	43	41	40	38	140
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	

Fig. 247.—(From Rosenau, "Preventive Medicine and Hygiene." Courtesy of D. Appleton & Co., New York, Publishers.)

ture when means are available for its regulation. By it one may ascertain the degree to which the temperature falls when there is evaporation of water from a wet cloth wrapped about the bulb. If it falls much, it would be assumed that the air was dry, in that it permitted much evaporation of water from the cloth. The usual drop in temperature should be about 8° to 10° F. after the thermometer so arranged is waved in the air a few minutes, providing room temperature is 65°–70° F. and the relative humidity about 55–65 per cent. It should be compared with another thermometer in the room that registered the same at the start. The two thermometers will register more nearly alike after the test when humidity is high.

The hotter the air, the more moisture it may contain. At about 68° F. considerable variation in humidity may exist without producing uncomfortable symptoms. Ideally there should be about 55 to 60 per cent of humidity at this temperature. If the air is suspected of too great dryness or moisture, adequate window ventilation will improve it, providing the outdoor air is not too dry or moist. In the absence of instruments to determine humidity, the effect of dryness may be observed on objects in the room and on the nasal mucous membrane.

Arrangements may be made for the evaporation of water in a room that is too dry. This will not be satisfactory in very dry air unless a considerable amount of water is evaporating constantly. In homes, the best that can be done is usually to keep the temperature such that variations in humidity are of less importance (i.e. 65–70° F.), and to allow sufficiently rapid interchange with outdoor air.

The movement of air indoors need not be so great as to cause a draught, which is a rapid concentrated current of cold air in one area. In fact a draught makes body temperature regulation difficult if the incoming air is much colder than that in the room. A faintly perceptible change of air is as beneficial and safer. The effect, outdoors, of a breeze that plays about the whole body is very stimulating. The chief health advantage of summer resorts is that they are breezy, and that one is likely to be out in the breeze. The

popularity of driving is at least partly due to the stimulus of cool air against the skin. Indoors a breeze may constitute a draught, but the opposite extreme, perfectly stationary air indoors, is equally undesirable. Air currents may be measured by the way in which a candle flame behaves. If it does not move at all, individuals sitting in the room will be likely to experience some of the lethargic effects of bad air, since the surplus warm air about them is not adequately removed.

Ventilation of rooms is necessary, then, primarily in order to secure proper temperature. In securing this, one usually has done what is necessary to secure proper humidity and air motion.

In overheated (or improperly ventilated) rooms, experiments have shown that the heart rate is increased at rest, and that there is a disproportionate increase upon standing or moving about. Other body effects are less marked except that there has been shown to be always a greater disinclination for any kind of work, although working power in spite of disinclination seems to remain the same, providing the disinclination to work is not too strong to be overcome.

Very frequently it has been observed that the rate of respiratory disease is greater among those who live in poorly ventilated rooms. In some disease conditions fresh air is a determining factor both in prevention and recovery (e.g. tuberculosis). In no disease can ventilation be neglected without danger, although the delicate and invalids usually like to be cozy.

The methods of ventilation are determined by the end that is sought—that of diluting the stale air, not its complete substitution for fresh air. The problem is to cause loss of heat about the body without producing chilling.

The first essential in securing adequate ventilation is sufficient space allowance per person. Wherever large numbers are living together, an increase of space per person results in increased health. Even cows give more milk and hens more eggs when they are in roomy quarters. A phenomenal reduction in tuberculosis occurred in one army regiment when more space was allowed in barracks There have been in history some tragic instances of overcrowding and death from

lack of ventilation. In the celebrated Black Hole of Calcutta 146 men were crowded into a dungeon with a space allowance for each of only 41 cubic feet, with ventilation through only a few small openings. One hundred and twenty-three succumbed to death after a night. The amount of space usually thought desirable in living quarters is about 700 cubic feet per person, and in sleeping quarters 1000 cubic feet. Rooms should not be less than 8–9 feet in height. In estimating space per person, the height of the room above the top of the highest opening should be discounted. In the ordinary public building, with ceilings twelve feet or more from the floor, at least 15 square feet of floor space per person is necessary, which gives 225 cubic feet of air space. This is sufficient in a large room, which may be more easily ventilated than a small one, without causing draughts.

Large "airy" rooms may not be so well ventilated as a diving suit, however. The advantage of a large room is that it may be ventilated without the occupant being in a draught. In small rooms the incoming air should be diverted away from the persons in it. Another advantage of large rooms and much space allowance is that there is less close contact between the occupants and less possibility of communication of disease. The disadvantage of small rooms in this respect should be counteracted by the usual measures to prevent infection from being distributed among its occupants by droplets.

Adequate space allowance having been secured, the next step is to see that the air in it is actually sufficiently often diluted by fresh air. This may be done by windows and doors, or by mechanical means.

The mechanical devices blow fresh air into a room (the plenum system); or suck the bad air out (the vacuum system); or do both (the combined system). Although these systems insure air getting in and out, they usually depend for their correct working on having the windows closed. Since it is hard to keep all the windows closed, these systems are not always preferable to window ventilation. They are used to great advantage in industrial plants especially.

Window ventilation gives better results in living quarters usually, and often in schoolrooms. There should be a window

area that is at least one-tenth of the floor area. The windows should be open at least a very little all the time. If disagreeable draughts are produced, the air may be deflected by the use of window boards. Although it is desirable to have an opening both at the top and bottom, or on opposite sides of the room, it is not necessary, for air may both enter and leave by the same opening. The amount a window is to be opened depends on the temperature outside and inside. It is not necessary to be at all wasteful of heat in winter. By opening a window in a moderately heated room even so little as an inch at the top, it is possible in winter to get 3000 cubic feet of fresh air per person per hour, because outdoor and indoor temperature are so unlike that a change in both temperature and air movement in the room takes place when cold air is admitted through small openings.

The test of inadequate ventilation should be the comfort of the individual and his psychological and physiological inclination to work. The latter criterion is important, for one may be so used to bad air, especially after having been in it for a time, that it does not seem uncomfortable. The discomfort that is present may be attributed wrongly to other causes, when perhaps nothing but the ventilation is at fault. Poor ventilation, although by no means the only cause for disinclination to work, is more often so than is realized.

Very little is to be said about the percentage of carbon dioxide. Actually it will usually be low if ventilation is good, because the same process by which temperature, humidity and air motion are made favorable, will at the same time reduce the carbon dioxide. The harmful effect of bad air, as has been said, is not carbon dioxide, however. Real harm from carbon dioxide (suffocation) does not result until it is present in quantities never found in natural circumstances. Sometimes air is tested for carbon dioxide to determine, by it as an index, the efficiency of ventilation, for it takes about the same amount of ventilation to keep the physical qualities of the air good, as to keep it low in carbon dioxide.

There are no diseases due to air as such. It is only as air carries droplets from the respiratory tract of individuals near by, or as the dust in the air carries germs, that it can be con-

sidered the bearer of disease. It is desirable to keep the indoor air as free from both droplets and dust as possible. Not many bacteria live long in the air, however, even on dust. Dust is harmful more particularly in that it is irritating to the respiratory tract and may thus predispose to infection. Efforts are justifiably made by communities to limit the contamination of the outdoor air by dust and smoke, and by industrial plants to limit dust in indoor air.

A change of climate, in order to get better air, is often recommended for those who are ill. The chief advantage one climate may have over another is that it permits of more outdoor life and has more sunny days. Generally speaking, it is possible to live so as to be well in any climate, although it may be harder to do in climates that are damp and rainy, extremely cold or extremely hot. The advantages of country air over city air are very slight—the good results of living in the country being largely due to the fact that one is more often out in the air in the country, and is leading a more hygienic life generally.

Whether ventilation indoors is good or not, a certain proportion of the twenty-four hours should be spent actually in the open air. The minimum amount for a sedentary indoor worker is thought to be about one hour. This should be in addition to spending the night in air that is as nearly like outdoor air as possible. Whether one sleeps out or not makes little difference so long as plenty of air is available. Chilling is to be avoided in open air or outdoor sleeping by having plenty of light bed clothing, and especially by sleeping on a thick mattress so that cold air will not get in from below. There is no virtue in being cold at night, for it interferes with complete rest and puts a strain on the temperature regulating system.

Not the least of the desirable factors in outdoor air is the sunlight it contains. There are ultra-violet rays given off from the sun that do not penetrate ordinary glass, that are powerfully stimulating and disinfectant. They are used for the cure of bone and skin diseases especially. The quality of the blood is improved by the increase of hemoglobin and of the number of leucocytes. No one can afford to be without the health-

giving effect of sunlight. Pliny said "Sol est remediorum maximum." It is not only a remedy but a preventive of many ills. All in all Walt Whitman was right when he said, "Now I see the secret of the making of the best persons; it is to grow in the open air." No system of indoor ventilation will ever quite compensate for a failure to spend some of one's time outdoors every day.

CHAPTER XXXIX

THE HYGIENE OF TEMPERATURE REGULATION

The body's automatic control of its temperature, even against great odds in physiological and environmental conditions, such as would tend to cause the temperature to rise or fall, usually succeeds in holding it at the normal 98–99° F. It is sometimes necessary, however, to aid the body in its efforts.

There is much that man does, with other ends in view, that would influence body temperature were it not immediately regulated automatically. The tendency of exercise, food, bathing and clothing, to affect temperature has already been referred to in the chapters dealing with these matters. It remains to summarize here the effect of procedures of these various sorts, and to draw attention briefly to the ways in which one may voluntarily assist in temperature regulation. What one does may make the task too hard, or even impossible. On the other hand, what one does may make the task too easy, and may fail to give the regulating mechanism sufficient practice in performing its work.

If circumstances are such as would tend to cause the body temperature to rise if there were no temperature regulation (as in homoiothermal animals), man's temperature will remain even, especially if he aids in the process according to the knowledge he has of the ways in which heat production may be limited.

On a very hot day or in a very hot atmosphere the body itself tends to become heated; but the body responds by an increase of perspiration that cools it and the body temperature does not ordinarily rise. It may rise, however, under certain circumstances. These circumstances involve, first, excessive exposure to heat or to the sun. One may voluntarily limit the warming of the blood by avoiding too prolonged and too

excessive exposure to heat, to which the body might have difficulty in adapting. Under such circumstances the taking into the body of hot food and drink, and the application of heat by means of hot baths, would add to the possibility of the heating of the body. Although ordinarily not a source of difficulty, such procedures should at times be thought of as placing an added burden on the temperature regulating mechanism, which might prove incapable of responding sufficiently rapidly and completely to hold the temperature even.

Since it is known that exercise increases metabolism, when the body is burdened by having to deal with a tendency of the temperature to rise (as in a very hot atmosphere or during a fever) one may voluntarily limit heat production by giving the muscles somewhat less to do. The organs too may be called on for less activity, since all organs when active generate at least a little heat as a by-product of the metabolism that goes on in them. Especially is this true of the muscles and of the glands. Even the work of digestion adds somewhat to the amount of heat produced. Habits of inactivity in general are adopted by dwellers in the tropics. The superior achievements of those who live in temperate climates is quite generally observable, and is to be attributed to the unhampering effect of the climate, which does not make limited activity physiologically preferable to activity, but the reverse.

The limitation of food intake is another means of easing the task of temperature regulation under circumstances that would tend to cause it to rise. One may limit the degree of metabolism possible in the body, by limiting the material that stimulates it. Reducing the food intake does not always affect temperature, since the body may metabolize its own substance, and does so in starvation. The temperature may even be higher than normal (as in fevers) when no food is taken. Nevertheless heat generated in the body is to some degree the direct result of the ingestion of food. As has been mentioned, protein in particular has a specific dynamic action in raising temperature.

It should be borne in mind that it is not necessary in hot weather to forego all activity or to cease eating, since the

temperature normally is regulated by the body itself, without assistance. If it does need assistance, the foregoing of excessive activity and the limitation of food intake, especially of protein food, would be among the means chosen.

Finally, when it is desirable to assist the body in keeping cool, one may limit the retention of heat in the body by limiting the amount of clothing worn. Lighter clothing permits the body heat to escape more easily than does heavy clothing. Loose clothing permits the breezes to gain access to the skin to blow away the heated air next it. Artificial breezes may be created by electric fans or by driving, for the same purpose. Cool baths conduct heat away from the body to the water. The drinking of cold water or other beverages helps to cool the body, and also provides more fluid which may be evaporated on the skin. Liquids at any temperature have the latter effect.

Those who suffer from exposure to heat are usually those whose temperature regulation is not satisfactory—the aged, infants, and the feeble. If the mechanism is in order, no bad results follow short exposure even to excessive heat, and may not follow long exposure at uncommonly high temperature if not too much physical activity is being performed and the individual is not too heavily clothed.

When the weather is cold the efforts the body makes are in the direction of increasing heat production, by increase of metabolism. In order to assist it voluntary efforts may be made of the same sort. In the cold the muscles acquire greater tone, and whether they are voluntarily used or not, increased metabolism goes on in them. One may assist in the production of heat by voluntarily using the muscles in exercise. In cold weather the appetite usually increases, in order that more food may be taken and metabolised, and more heat produced. One may voluntarily eat somewhat more than is one's custom in warmer weather, especially more protein. Some of the food and drink will usually be preferably hot. Hairy animals grow thicker hair in winter, but man can only aid in the conservation of body heat by adding to the amount of clothing. Animals protect themselves as best they may from the cold breezes, and man does the same by establishing himself in a house

provided with a heating apparatus. When the body is cold the application of warmth by means of hot baths aids in the warming of the body. (The effect of cold baths followed by friction of the body should be recalled as a means of increasing metabolism and body heat, rather than of reducing it. The ultimate effect of baths is not always what would be assumed by their temperature.)

Some or all of these measures to aid temperature regulation may be required at times. But just as it would be harmful to avoid the use of any other function of the body, in the effort to avoid strain of it, so is it harmful to avoid the use of the temperature regulating mechanism to prevent its strain. If one never gives the mechanism enough to do, it becomes unable to make its adjustments easily and well on the occasions that are bound to arise when they must be made or disaster result. The aim should be to develop quick and complete adaptation to ordinary temperature changes, and to know how to aid the body voluntarily if necessary.

Temperature regulation may be trained. In fact it has to be trained, for one is not born with a very satisfactorily working mechanism. Unless it receives training the individual is made uncomfortable, or perhaps ill, by the variations of external temperature in either direction. The method of training it consists of permitting it to become accustomed to various temperatures and to sudden changes in temperature. If the body is always in an even temperature, and always fully protected against cold, it loses some of its adaptability to temperature variation. It is best trained by a moderate exposure such as comes by going outdoors in all sorts of weather, by keeping the indoor temperature fairly low (65–70° F.), by not wearing too heavy clothing, by much exercise while lightly clad, and by cold bathing.

If the mechanism is spared as much as possible, the individual becomes very susceptible to chilling and is likely to have frequent colds, and perhaps other forms of ill health. Those who are always bundled up and protected from all exposure to cold, usually may count on a lower rate of metabolism, loss of muscle tone, impaired circulation, the accumulation of fat, and a poor color.

In order to be in condition to stand exposure well, one must provide the body with the means of making its own adaptations to cold by giving it plenty of food, and securing an adequate circulation. It is not enough merely to expose the body to cold and to rely upon it to adjust, unless one provides it with the facilities for adjusting. Exposure will result in immediate damage, instead of benefit to temperature regulation, unless these preparations are made. Furthermore one should be prepared to exercise enough to keep warm or to make other changes if chilliness appears. There is no better preparation for a cold winter than outdoor exercise in the fall, which exercise should be continued through the winter.

Temperature regulation is most difficult under circumstances when part of the body is cold and the rest warm. No one can count on freedom from harm, for example, when the greater part of the body is warm, perhaps perspiring, and the feet are wet and cold or a draught is blowing on the head and neck. Pasteur stood a hen in cold water until the general body temperature was reduced and then succeeded in inoculating the hen with the bacillus of anthrax, to which the hen is ordinarily immune.

Not only may general lowering of the temperature follow local lowering of it, but certain parts of the body may become congested, especially the mucous membranes of the respiratory tract. Any marked inequality of temperature about the body should be avoided. There is much less danger, in fact almost none, if the body is kept moving under such circumstances. Walking in wet shoes, for example, seems to do little harm; but if it is necessary to sit still in wet shoes, harm is likely to result, since heat production is at that time reduced by the inactivity. The hygiene under cirumstances of chilling should involve immediate efforts to get the body warm.

When the body temperature has risen in sunstroke or heat stroke efforts are made to get the body cool by any available means. When fever is present because of infection, efforts are usually confined to limiting heat production by limiting exercise and, to some degree, the food intake. Fever is sometimes treated in other ways when it ceases to become an advantage to the body in coping with infection, and becomes instead

a direct menace in itself. When it is very high, for example, the application of cold to the body may be used. Drugs that reduce temperature do so either by reducing metabolism, or by promoting perspiration, or by acting directly on the heat centers in the brain. They are usually not used if the body is presumably profiting by the effect of the temperature and is not being taxed too heavily by the temperature itself.

Since one of the important automatic methods used by the body to lower its temperature is that of increasing perspiration, this process is to be assisted, in many cases of increased body temperature, by a warm bath and by the drinking of much water. Water drinking is desirable not only for this purpose but because, by increasing the volume of urine, it also aids in the elimination of the bacterial or other toxins that are causing the fever. It should always be recalled, however, that when the body is trying to get rid of heat by perspiration the exposure to cold may cause much too rapid evaporation and cool the body more rapidly than is safe.

CHAPTER XL

THE SKIN, HANDS AND HAIR

The care of the skin ought to be one of the most successful aspects of hygiene, because the health of no other part of the body, and the result of varying procedures to secure its health, may be so readily gauged by the eye. The appearance of the skin is to a considerable degree indicative of its health. In fact measures are usually taken primarily to secure the good appearance of the skin, often the individual not considering the fact that its health and the health of the body are the chief underlying determining factors. Skin standards involve somewhat more than its good function. The skin must not only do its work but must be ornamental, or at least not objectionable in appearance. The latter aims are not properly those of hygiene, but since hygiene is involved in attaining these aims, it may be temporarily supposed that hygiene not incidentally but deliberately seeks beauty. The same considerations apply in respect to some other matters of hygiene. Good posture is sought for its health benefits, but incidentally what is done for health also produces a better appearance.

Whatever is done for the health is almost inevitably reflected to some degree in the skin, for the skin shares in the nutrition and circulation of the whole body, and whatever influences the whole body for the better, can hardly help conferring some benefit on the skin. A healthy or beautiful skin rarely grows on an ailing body. An unduly thin person rarely has as good skin as one who is better nourished. Even slight departures from health may lead to a pasty or sallow color, and to eruptions. The effects sometimes show quickly. After a short illness, even, the skin may look pale and muddy and be in a state to become infected easily. Sometimes the disturbance of health is not such as to attract attention, except as the skin shows it by changes in color, texture and quality. Perhaps

one reason that a good skin is so highly valued is that a poor one suggests both disease and dirt. Negligence of the skin may be suspected, yet the individual may be doing his best to keep his skin in order, although he may often be unconsciously neglecting that which would make the task easier—that is, attention to matters remote from the skin but related to it.

Many kinds of poisoning of the body are likely to show in the skin. Especially is this true of poisoning from the digestive tract. But poisoning from other parts of the body that are diseased or infected may produce skin trouble. No organ can be neglected in the care of the skin, or indeed of any other organ. The bacteria causing skin eruptions, for example, may have their breeding place in diseased tonsils. Not infrequently objectionable skin conditions respond to the removal of foci of infection.

The effect of an active circulation is the same on the skin as it is elsewhere—the effect being that of more complete nourishment of it and more complete removal of waste from it. If bacteria are present on or in the skin, they will have less resistance offered against them if skin circulation is sluggish. In this way even so remote a matter as posture has an indirect effect on the skin. There are some diseases that regularly present certain skin manifestations. If a skin abnormality is due to disease or to faulty care of other organs, all the local care in the world will not produce much result.

Not all skin conditions, however, are dependent on general health. Some are due to local conditions—that is, to causes operating directly on the skin itself primarily. If the complexion is bad, it may be entirely due to surface irritation or infection, or partly due to general condition perhaps. In order to be certain of a good skin, neither the general care of the body nor the local care of the skin itself may be neglected.

There are various types of skin, according to natural structure and thickness, and according to color and amount of hair. Skin varies from opaqueness to relative transparency. The former is found more often in southern races and the latter in Anglo-Saxons. The opacity is due to the skin being composed of more layers of epithelium. It is often, although not always, accompanied by a large amount of pigment in the deep

layers. Blondes usually have thin skin. Pallor in an individual with thick skin does not necessarily indicate faulty circulation, for the blood in the capillaries may not be able to show through so many layers above it. It will be recalled

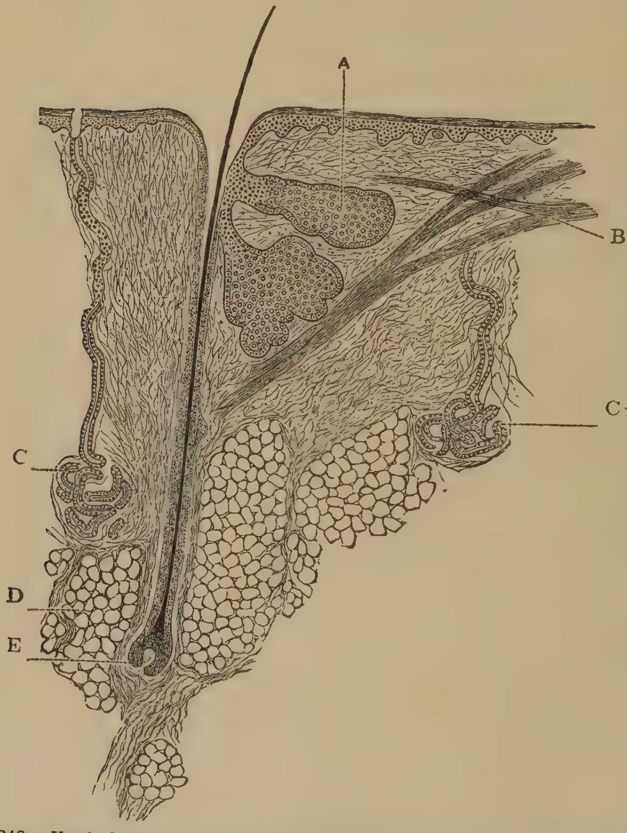


FIG. 248.—Vertical section of the skin. A. Sebaceous gland opening into hair follicle. B. Muscle fibres. C. Sweat gland. D. Fat cells. E. Fundus of hair follicle. (From Halliburton, "Physiology," 15th Edition.)

that the blood vessels do not extend to the outermost layers of the epithelium. Opacity is sometimes due to an unnecessary accumulation of dead epithelium. In all individuals the opacity is less about the eyes, and faulty circulation shows there as dark circles. The advantage of a thick skin is that

it is less sensitive to harm and less prone to wrinkle. The disadvantage is that it is likely to be accompanied by large duct openings, and sometimes to more profuse hair growth.

The size of the sebaceous duct openings varies remarkably. In some individuals they cannot be detected at all, and in others each one is plainly visible. The reason that they are more pronounced in coarse, thick skins is that such skins need more sebum to keep them lubricated. The brunette and the individual with much hair is likely to have larger ducts, and the skin consequently needs more care to keep it free from plugged-up ducts and blemishes. The early care of such a skin may prevent much trouble later. The duct openings cannot be made fewer or much smaller. About all that can be done is to keep them open and clean.

The variation in color depends very definitely on inheritance according to the Mendelian law. Pigment in the skin increases up to middle age, and thereafter tends to decrease, just as it does in the hair. It also increases temporarily upon exposure to the sun, perhaps in spots. There is no way to get rid of the pigment in the skin, or to lessen it. Time alone diminishes that due to sun. The pinkness of the skin is due to the blood in the capillaries, which shows through if the skin is thin enough, although it may show through even a thick skin when there is more blood present than usual. The amount of blood present varies from time to time, often rapidly, according to the activity of the vasomotor system. It will be recalled that emotions have a great effect on the vasomotor system, producing blushing of the whole face, or merely heightened color in the cheeks. Irritation by wind, heat, cold, or rubbing produces similar reddening.

The external damage to the skin is largely the effect of dirt. The face needs more care than the rest of the body (except the hands), because it goes about uncovered, and receives much dirt and smoke from the air, both by day and by night. One must put up with this, but it is not necessary to add to it by putting more dirt on the face by touching it with dirty hands, or dirty powder puffs, or gloves soiled by perhaps a season's dirt, or handkerchiefs that have been carried about and perhaps used all day. Fur collars harbor much dirt, even if the

dye itself is not chemically irritating. Unless they are kept clean, they may soil the neck, or the face when they are turned up.

The ducts of the sebaceous glands stand ready to catch any dirt and bacteria that come along. The bacteria, after getting in, do not always cause trouble at once, but are ready to do so when the general resistance of the skin is lowered by ill health (even by so slight a degree of disturbance as may be occasioned by the menstrual period), or when irritation of the skin occurs, as for example, by rubbing it too vigorously.

Outside contamination should be avoided as far as possible by keeping the skin clean. This is to be accomplished by careful washing. It is hard for some individuals to look merely clean, but skilful washing will usually produce much improvement. Skilful washing does not mean severe or excessive washing. The method varies with different kinds of skin, and should be specially prescribed if there is any skin difficulty.

No other cleansing agent is as good as water. Ordinarily, water neither too hot nor too cold should be used. The hands should be thoroughly cleaned first. Then the face is to be washed with the hands from a bowl of fresh water. This requires a good deal of free-lathering soap. Then still another bowl of water is to be drawn and the face rinsed in water of moderate temperature. It may be finally rinsed in cold water, if it is not too delicate a skin. If it is delicate and tends to get either too dry or too oily, cold cream may be smeared over the face first, and then thoroughly washed off. This cleansing washing should be done at night because the face is dirtiest then. In the morning no soap is needed. The clean hands are preferable to a face cloth, unless one can have a clean one each time the face is washed. Even then, the hands are less likely to irritate than a cloth.

Extremes of temperature are stimulating to the sebaceous glands and the skin circulation. The thick, tough, opaque skin may benefit from such stimulation, but the thin skin characteristic of the Anglo-Saxon does better when extremes of temperature are avoided. Those of this type also usually find that the stimulation of rubbing with the towel is not desirable, but prefer to pat the face dry. Towels should either be fresh

each time they are used, or carefully protected from dirt, and from contamination by contact with the towels of others.

The appearance of very many individuals is marred by a condition known as acne ("pimples" and "blackheads") which occurs chiefly on the face and the upper part of the chest. At puberty there is an increase in the size of the duct openings on the face, which makes infection more likely. When there are pimples, there is always infection locally, but there may be general causes for the condition also. The spots themselves should be treated very carefully, so that no more infection shall get in. Rough, careless opening of them may make more of them appear near by. If there are many, medical advice should be had. Often the correction of the diet by limiting sweets does away with the tendency to acne, especially if constipation is prevented and the general health made as good as possible. Acne is less common in those who live outdoor lives. The washing of the face is an important matter in acne, for keeping the dirt from accumulating in the pores makes them less conspicuous. Generally it is better not to use face powder in such cases, as it may fill the duct openings and make infection easier. Talcum powder is less likely to do this. Sometimes vaccines made of the bacteria found in the pustules themselves may increase resistance to such bacteria. Sometimes local medication is needed. Acne has no relation, as is sometimes thought, to any particular "bad habit," nor does it usually indicate any "blood disease."

Boils are much the same as large pimples, but they often occur in those who do not have acne. They are usually preventable by avoiding irritation of the skin, especially the irritation produced by the rubbing of soiled clothing. In any case there should be medical treatment of the boil and an investigation of its cause, which involves examination of the urine.

Any unusual eruption should not be self-treated. It may be an acute disease of the skin (such as "itch"), or one of the diseases of the whole body that produces eruption (measles, scarlet fever, etc.). Food indiscretions or food poisoning often produce temporary eruptions that have no special significance and go away quickly, but it is not fair to others to wait and see

whether an eruption will go away. Even if it does, it may have been "catching" while it lasted, and may have been communicated to others.

There is nothing to do for freckles and tan, except to avoid the sun, but for general health reasons it is better to allow the skin to become browned than to avoid the sun. Sunburn, however, should be avoided if possible, and if it occurs it should be treated. If extreme exposure to sun may not be avoided, upon coming in from such exposure the face may be covered with cold cream and then thoroughly powdered with talcum. If this is done at once, no water applied, and the cream and powder left on as long as possible, at least overnight, sunburn should not be serious. If it does appear to be serious, it should be considered in the class of other burns and have medical attention. Occasionally quite serious infection follows uncared-for sunburn.

Moles and warts should never be self-treated. The removal of them is a matter for physicians.

Wrinkles are a defect of the skin which may begin quite early in life. They are due to several causes, of which the most important is the loss of fat under the skin, so that the epidermis lies loosely on the underlying tissue and forms folds. Skins that produce too little sebum, or have too much of it daily washed away, become drier and hence wrinkle more easily. A very dry air in houses, or very drying lotions, or too drying soaps (alkaline) have a similar effect.

The factor that determines the wrinkles, given a skin in a susceptible state, is the prevalent habitual motions of the face muscles. An individual who contorts the face, or grimaces, or contracts the muscles frequently and strongly in emotions, is likely to produce wrinkles. Such intense signs of pleasant emotions produce lines that are not objectionable. But many of the lines that accompany disagreeable emotions—such as the long lines leading downward from the nose to the mouth—mar the appearance. The lines from habitual facial contractions are not necessarily associated with any emotions, but may be merely habits. Such lines in the forehead are often due to eyestrain, in which the tissues about the eyes and between the brows are contracted in the effort to make vision

better. Early wrinkles are most often due to this cause. During sleep the face muscles relax and the wrinkles are to some degree obliterated. Enough sleep is, for many reasons, necessary for the improvement of the skin.

The care of the skin is an important part of the life work of some very vain women, but its care may be adequate with the use of very little time. There is a tendency in youth to think that one's present pleasing appearance will remain through life, or that if it does not, one will be beyond caring how one looks. This is, of course, not the case. At any age one has a right and a duty to look one's best.

Those who spend much time and thought on keeping beautiful often rely a good deal on cosmetics, but the most successful do not rely on them solely, or perhaps not at all.

The use of cold cream is for several purposes. First, it may be used to cleanse the face. It has been said that Madame Patti never washed her face in water. The same has been said of other beauties, but there is room for doubt of the truth of the statements. Either the statements are false, or the individuals always had very dirty faces. The use of cold cream for cleansing the face is quite limited. It may be used when the face is quite soiled, as a preliminary to soap and water, or as a substitute for soap and water in the case of the evening washing of the skin that is very dry or irritated. In extreme cases, no soap would be used in the morning, but only clear water. Such departures from the usual procedure should always be under medical supervision, however.

Cold cream is also used as a lubricant of the skin. Sebum is nature's cold cream, and it should be sufficient unless too much of it is washed away, or the constitutional condition or the environment renders the skin too dry. Cold cream is also used to soothe irritations. The use of it for sunburn has already been mentioned.

There are two main varieties of cold cream; those that are greasy, and the sort known as "vanishing" creams. There are those that are supposed to be skin foods, but they are not actually so. No nourishment for the skin can be absorbed through the surface, but only from the blood underneath it. There are creams that are advertised to reduce fat, but none of them

produce this result, except as the massage itself helps in this direction.

Greasy creams may profitably be used for cleansing the skin just before washing it, or they may be applied afterward and left on all night to soften a dry skin. They should not be rubbed into the skin except when it is clean, for this procedure will carry any dirt that is present into the duct openings. Greasy cold creams are not suitable to apply before powdering the face when going out, as the grease soon shows through the powder.

Vanishing creams also should be applied only when the face is clean. They may be used under powder, if one uses powder, but should be washed off at night. The skin in its natural state usually catches less dirt than one bearing any kind of sticky substance.

Liquid creams usually contain glycerine, together with rose water, witch hazel or boric acid. Sometimes an individual cannot use glycerine because of an idiosyncrasy against it. These lotions soften the skin, tend somewhat to the healing of roughness, and protect against chapping if one must go out immediately after washing.

Instead of being soothing to the skin, even ordinary cold cream may, in some cases, produce irritation. Some sorts of greasy creams tend to start hair growth in the susceptible. Some of the "beauty" creams most highly advertised as having miraculous powers, contain lead, from which lead poisoning may arise. If creams are used, they should be of well-known composition, and no magic should be expected. The chief advantage of creams is for softening the too dry skin, protecting from the weather or the effects of it, as an aid to ridding the skin of dirt, and at the advice of physicians as a means of applying medication.

The use of powder in itself is less objectionable than the way in which it is often applied. A much-used powder puff is both a hygienic and an aesthetic offense. Nothing should be rubbed on the face which is not perfectly clean. After using a material once to apply powder, it should not be used again for the same purpose, for in using it once it not only applies powder but takes off the surface dirt of the skin also.

Absorbent cotton, that may be discarded, is the best material to use. If the nose will not stay powdered all day, another method of keeping it from shining should be devised, rather than continuously repowdering it.

Powder, as sold, is of three chief varieties: talcum powder alone, rice powder alone, or either used in combination with chemicals. The various chemicals sometimes used with them may or may not be injurious. Powder should be looked on as white dirt instead of black dirt in respect to its possible clogging of pores. Talcum powder is a mineral, and at least does not decompose in the skin as rice powder does. A vanishing cream used underneath the powder, tends to keep it from getting into the skin ducts. If the pores are not large, powder does not appear to do much, if any, harm. If the pores are large, the effect of powder in filling them makes the skin look better, and perhaps keeps out other dirt. It is better to try to get the skin into a state that does not call for either powder or cream. If this is not possible, then the effect of any beautifying agents should be watched in order that they may be changed if signs of trouble appear. The skin should not be powdered when it is dirty or damp.

If cosmetics do not contain harmful chemicals, they appear to do little harm to the skin, if thoroughly removed at night. From the health point of view there are no special reasons against them, unless they contain injurious chemicals. It is thought that they may cause earlier deterioration of the quality of the skin. Opinions differ regarding their aesthetic value. Some individuals prefer the semblance of health, as contributed to by powder and rouge, if they cannot have a genuine appearance of health. Others scorn counterfeit beauty. Still others consider the use of cosmetics an easier path to beauty than that of hygiene. In looking at an individual who is heavily "made up" there are those who cannot avoid wondering what lack is being covered up. They wonder how unsightly the individual would be without it.

Among the many beauty fads are the "complexion clays." They accomplish at best only the removal of the outer layers of the epidermis. Neither such treatment nor the peeling or scraping of the skin, changes its essential character. They

are not to be recommended. Defects in the skin should receive the attention of a physician who specializes in this branch of medicine.

Massage of the face is in a different category. Both that and facial exercises may be used to relax strained facial muscles and to overcome the effects of habitual motions, and to improve the tone of muscles and of circulation. If massage is of the right sort, it may be very useful, especially at middle age. If badly done, it may cause irritation of the skin. It should always be done by an expert.

The Hands

Religious rituals, even as far back as the ancient Hindus, included rites regarding bathing. The code of Manu gave specific directions for washing the hands. The right hand was to be washed ten times and the left seven times. Had those ancients had modern bacteriological knowledge, they could not have done better than to prescribe as they did. If a person doubts the necessity for frequent hand-washing, let him wear a pair of white gloves a day and observe the dirt they collect. A good deal of this dirt is "clean dirt," however; that is, much of it is merely colored material, and not contaminated by pathogenic bacteria. The real test of the dirtiness of dirt is to deposit some of it on a substance where bacteria grow readily, and, after leaving the substance in a temperature which is favorable to bacterial growth, to examine it for bacteria. Real dirt is that which may be colorless, even invisible entirely to the naked eye, but will yield a growth of bacteria upon such a medium. Bacteriological dirtiness is that which one seeks to limit, and it is very hard indeed to limit it.

Evidence regarding the cleanliness of hands has been accumulated from the experience of surgeons. In no circumstances is it more important to have the hands clean than when they are about to be used in a surgical operation on the human body. All experiments so far have shown that the hands cannot be made clean enough for such a purpose. Hence the surgeon wears absolutely sterilized rubber gloves, after getting his hands as clean as possible by a "surgical scrub." This

consists of many minutes of scrubbing with soap and a sterile brush, followed by the use of a sterile orange stick, and the soaking of the hands in two different antiseptic solutions. Even after such measures, a lively growth of twenty or more kinds of bacteria may be grown on a "culture medium" as described above, if the hand is drawn across such a substance on which bacteria may be cultivated.

After finding thus that it is impossible to get the hands clean, there is only one conclusion to be reached—that the hands should be kept as clean as possible, and then be kept away from the easily infected parts of the body.

Hands are contaminated by bacteria from many sources, even from one's own body and its secretions and excretions. The bacteria that do no harm, however, in the intestinal tract, for example, are capable of causing much harm on some of the other mucous surfaces. It is desirable to wash the hands frequently. A group of hygienists recently spent a long session discussing the requirements for children regarding washing the hands. The conclusion reached finally was that children should be taught to consider their hands not perfectly clean at any time, and consequently to be kept as much away from the body apertures as possible. Rubbing the eyes, scratching the lids, putting the hands into the mouth and the nose, are dangerous habits. Somebody has said that if saliva were blue, one's hands would be always blue, because of the frequency with which they are unconsciously put to the mouth and lips. Children, of course, are the worst offenders, but many adults continue the habit. Nail-biting is absolutely unsanitary, in addition to being unaesthetic and indicating undesirable personality traits.

Accepting the fact that hands are not, ever, quite clean, they may be kept free from gross contamination by washing them, especially after performing the toilet necessities. Before eating, a last effort should be made to free the hands of some of the bacteria usually present, and while eating the food should not be handled more than necessary.

The hands are tough and will stand a good deal of washing. A scrub brush and orange stick should always be used. No chapping will occur if all the soap is rinsed off, and one does

not expose the skin to cold air before it is perfectly dry. The brush should be an individual one, not too stiff nor too soft, and should be frequently sunned in the open air.

The nails need special attention, because their point of union with the skin is rather delicate. The skin tends to adhere to the nail and, as the nail grows, to be stretched and easily torn. "Hang-nails" result unless the skin is kept pushed back, which should be done when it is soft, after the bath. If it tends to get dry, cold cream may be used at night to soften it. A blunt orange stick may be used if the cuticle has grown up much, but if it is kept back, the towel is all that is needed. Ordinarily it should not be necessary to cut it. If it has been permitted to grow too long, and has become a fringe of broken cuticle, it is better to cut it, and then in future to keep it from such growth and damage by daily care. The cutting must be done skilfully, to avoid nipping the skin that is not dead. If a hangnail forms, it should never be pulled away, but always cut. Certain acids are in fairly common use for the removal of cuticle. They tend to make the cuticle excessively dry, and hence induce hangnails. Their effect on the nail itself is not particularly good. In any case they should be washed off at once.

It is better to do one's own manicuring than to patronize public manicures, unless one is certain of the sanitary precautions taken, and also of the manicurist's dexterity in avoiding small injuries.

The nails themselves should be filed rather than cut. A natural outline is preferable to an unnaturally pointed one, since the point may be broken. A narrow margin of white should show beyond the red bed of the nail, but any excess of length is likely to lead to injury of the nail.

The color of nails is naturally red because of the circulation underneath. Only when the circulation is poor is tinted polish necessary. Polish itself is not injurious, and to a moderate degree causes nails to look as they should without it, slightly glossy. The natural gloss is taken off by those who have their hands much in water.

Under the margin of the nail much dirt tends to collect. It is better to remove this with an orange stick rather than

with the pointed end of a file, because the latter causes a slight roughness that makes the nail catch dirt more quickly. The same is true of the chemicals which are sometimes put under the nail to give whiteness.

Ridges sometimes appear in nails. They may or may not have significance, but are usually not significant of any serious condition. Spots of white on the nail usually result from damage to the nail in manicuring, the root being injured when the cuticle is pressed back. Sometimes they are due to slight blows on the nail such as pianists and typists receive in striking keys. Usually under such circumstances they may be prevented by wearing the nails shorter. They are never indicative of constitutional disease.

Redness of the hands may be due to skin irritation, in which case it may be prevented by using a suitable lotion and by washing and rinsing the hands properly. It may, however, be due to faulty circulation. The latter is likely to be accompanied by coldness and moisture, the former by dryness and warmth. A physical examination is needed for the cause of the poor circulation.

The Hair

The health of an animal is gauged somewhat by the thickness and glossiness of its coat. Hair in humans has not quite the same significance, although it often bears some relation to health, especially to nutrition. The same individual in health is likely to have a better crop of hair than in sickness, at which time it is likely to be thinner and to have less lustre. In some diseases—as, for example, typhoid fever—it tends to fall out in large quantities, and to regrow as the health returns.

The amount and the quality of the hair depend on the scalp from which it grows, and this is greatly affected by general conditions, but it is probably as often affected by local conditions. The kind of hair, and to some extent the amount and quality, is definitely determined by heredity. It is also influenced by endocrine secretions. In some endocrine disorders the distribution of the hair is changed, and in others the total growth throughout is either more or less abundant. Within these hereditary and constitutional limitations, there is oppor-

tunity for much variation in the health of the hair, however.

The hair is perpetually falling out and growing anew. Because some hairs fall out, it is not to be concluded that the hair is necessarily growing thinner, for an equal number of new hairs may be taking the place of the old ones. The exchange of old hair for new takes place more rapidly in some than in others. There is also a difference in the rate of growth. The average rate is about a quarter of an inch a month, although it may be much faster. It may grow to a great length in those who do not shed the hair rapidly, but retain the individual hairs for a long time.

When hairs fall out and are not replaced, a condition known as alopecia or baldness results. This is usually a diffuse thinning of the hair in women, and a locally more pronounced thinning on the crown of the head in men. Baldness may occur in sharply circumscribed areas. Complete denuding of the top of the head is quite common in men, but rare in women. There is apparently some hereditary tendency to early baldness in men, although it is not known whether baldness is not actually acquired in all cases. There is a tendency for the hair to get thinner in old age in both sexes. It seems to be a part of the aging process. When it occurs, it is likely that there will be other indications of aging as well, such as changes in the arteries. The other horny structures produced by the skin, the nails, will perhaps show changes too, such as a tendency to brittleness.

Baldness or thin hair may or may not be accompanied by dandruff. When this is present, the condition of the hair is usually attributable to that cause. Dandruff consists of an excess of sebum, which may form in dry scales, that may be shaken or rubbed or brushed from the scalp, or may consist of a greasy accumulation that adheres closely to the scalp. It is probably due to a parasite and may be "catching." Dermatologists (skin specialists) find it difficult to cure. Its prevention consists of cleanliness, and the use exclusively of one's own combs and brushes and hats. After it appears, much may be done to minimize it by keeping the scalp as clean as possible, which usually necessitates expert advice. Self-prescribed treatment may be too stimulating, and result

in producing still more sebum. If no treatment is used, there will be one of the two varieties of accumulation on the scalp and the ultimate thinning of the hair. Dandruff and acne are often found in the same individual, the sebaceous glands producing an excess of sebum on both scalp and face. Other skin diseases may accompany dandruff.

Falling hair may be due to deficient circulation locally, which may or may not mean deficient general circulation also. Local disturbance of circulation it is thought may be due to

FIG. 249.—Transverse section of hair and hair follicle. *a*. medulla or pith; *b*, fibrous layer; *c-h*, successive layers; *i*, blood vessels. (From Halliburton, "Physiology," 15th Edition.)

pressure of hats about the head, impeding circulation. Most hats worn by men, except very soft ones, do this to some degree. Overheating of the head seems to encourage parasitic growth and dandruff. Men who wear more or less air-tight hats, fitting closely, seem to have scalp difficulties more than those, chiefly women, who either go without hats or wear relatively loose-fitting ones. Although there is possibly some association between sedentary habits of life, poor scalp circulation and

baldness, the activity of the brain in itself cannot be considered directly responsible for loss of hair. Efforts should be made to prevent baldness by preventing faulty circulation in the scalp and by preventing an unclean scalp. It may, however, bear no relation to neglect of the scalp.

The hair may not be made to grow thicker by cutting or singeing the ends. Those in whom the hair grows long, sometimes find the ends split, and are urged by hairdressers and barbers to have it singed. All the singeing does is to improve the appearance of the hair by removing the split ends. The hair is not hollow, and nothing is "sealed in" by singeing.

Cutting the hair has no effect on rapidity of growth of the hairs cut, but may change their character, causing them to become coarser. Ordinarily the hair tends to maintain its established characteristics. Sometimes the top of the head is shaved in beginning baldness, but no evidence is at hand to indicate that any inactive follicles are thus made active or that any of the fine hairs are made much coarser. When regrowth occurs the individual has no more hair than before. Shaving the hair under the arm seems to change its character somewhat, but not markedly.

Sometimes the hair on the face of women takes on an unusual growth, and tends to become coarser. This is usually thought to be due to endocrine gland disturbances. Because of the possibility, not entirely disproved, of stimulating more and coarser hair growth by using depilatories or by cutting it or pulling it out, it is better, when such growth occurs on the face, not to treat it in any way, but to leave the hair alone, and to consult a dermatologist.

Depilatories, for the removal of hair, have only temporary use, their action being much the same as that of cutting, except that they may irritate the skin. No chemical can reach the root of the hair from which it grows, and if the root is not destroyed, another hair, which may possibly be coarser than the former one, will surely grow from the root. The best permanent method of removing hair is by the use of the electric needle, plunged to the root of each hair separately. If there are not too many, the process may not be too tedious in proportion to the results obtained. The X-ray may also be used,

but is not entirely free from the danger of leaving a scar, unless the operator is very expert.

Hair contains fatty granules with pigment. Absorption of these leaves vacuoles, which gives the hair a white appearance. Color cannot be restored except by dyeing the hair. As the hair grows, more dye has to be applied to the newly visible white portion. This makes the dyeing of hair a frequently recurring task. There are vegetable dyes, which skin specialists may prescribe, that are not injurious. Most of the proprietary ones contain either lead or other injurious substances. If there is lead in the hair dye that is used, general poisoning may result from absorption through the scalp. Some of the other dangerous chemicals in hair dyes lead to irritation of the scalp, which sometimes spreads over the face as well. Any "tinting" of the hair is open to the same objections as dyeing it, for it is dyeing, called by a name that seems to connote something less objectionable. Bleaching the hair by peroxide of hydrogen is a process that, like dyeing, has to be frequently repeated in order to keep the newly grown part of the hair of the same color as the rest. It is rather injurious to the hair, since it makes it dry and brittle; but it is not at all injurious to the health. The appearance of the individual may fail to be improved, both because of the lack of lustre in the hair and the usual lack of harmony in the color scheme when the natural hair color is changed. Hair color is hereditary according to the Mendelian law. The unmixed Nordic, for example, has blonde hair; whereas those of some other races have pure black hair. Any possible percentage of pigment may be found in those whose ancestors had both light and dark hair. A certain proportion of red hair may be expected in a family if an ancestor had red hair.

Lustre of the hair is dependent on its cleanliness and on the sebum produced in the glands that open about the hair root. Sebum may be in excess, so that the hair is oily rather than lustrous. Brushing tends to distribute the oiliness on the scalp along the entire length of the hair and to remove the excess of sebum. Too frequent washing of the hair may wash away too much sebum, so that the hair becomes dull and dry. This is particularly likely if any soap is left in the hair, or if it

is dried under too intense heat. The application of a small amount of brilliantine adds to the lustre of the hair without hurting it. It does, however, tend to make it catch more dust and to need washing oftener. Substances used to cause the hair to lie close to the head may or may not be injurious, but they especially favor the adhering of dust to the hair.

Hair tonics are of two varieties—solutions and greasy ointments. Neither should be used without medical advice. The solutions usually rely for their effect largely on the alcohol they contain, which dissolves much of the fatty sebum and may dry the hair excessively. They are often desirable for an oily scalp. Some of them contain substances intended to stimulate scalp circulation. Others are directed toward destroying parasitic growth. Circulation, if improved, is likely to be so because of the rubbing involved in applying the solution rather than because of the intrinsic character of the solution, although there are substances which may be prescribed that have genuinely stimulating properties. They may or may not be successful in stimulating hair growth in individual cases.

The greasy substances intended as hair tonics may help to take the place of an adequate secretion of sebum in a dry scalp, and may improve the appearance of the hair. Unless applied very carefully, to the scalp only, they give the hair an objectionably oily appearance. They should not be applied to the hair itself to "nourish" it, for the hairs are dead epithelium and cannot take up nourishment thus. If the hair needs treatment, it is better to consult a physician rather than to apply substances that may do harm. The popularity of substances originally intended to cure a parasitic disease of the skin in animals (mange) has been very great, but ill-founded.

If there is no disease of the scalp and no constitutional disease, most hair may be made satisfactory by suitable care, which care is not, however, the same for all individuals. It involves, first, the washing of the scalp and hair at proper intervals. Generally speaking, if the hair is carefully washed, it may be done as often as one wishes. Some even wash the head every day, with no apparent bad results. The main thing is to leave no soap in the hair, and to dry it thoroughly. When

it is washed as often as this, it is better not to use soap more often than once or twice a week.

Women's "crown of glory," if it is long, is likely to become a rather tarnished crown. Strangely enough, women who bathe daily seem often to have little corresponding interest in the maintenance of clean hair. They would be shocked to have it commented on that they had just washed their faces, yet show no embarrassment in a comment on the fact that the hair has just been washed. The fact that the hair waves more when it is slightly dirty should not be considered an argument in favor of dirty hair. The gain in appearance in this direction is more than balanced by the loss in others. Dirty hair is seldom, on the whole, as attractive, either to the eye or to the nose, as clean hair.

Adequate care of the scalp in women involves washing it at least as often as every two or three weeks, although those with short hair will prefer, usually, to wash it much oftener. In the intervals between washing the hair, it should be kept in a condition of cleanliness that does not make a shampoo too obvious a change. If the effect of the shampoo is such as to change the appearance of the hair radically, either the hair was undeniably dirty before it, or the shampoo was unnecessarily drying. The hair is exposed to the same amount of dirt as the face, except for the times when it is covered by hats. The hats themselves are usually quite uncleansable, and while keeping out dust may add dirt from themselves. One is unjustifiably optimistic in thinking the hair can be kept clean by a monthly shampoo and the daily use of a comb only.

The scalp itself is the most important part to wash in a shampoo. Any soap may be used that is not too strongly alkaline. Even though it remains on the scalp and hair only a short time, too strong a soap may be injurious. Shampoo liquids sometimes are too drying, in which case they make the hair fluffy, so that it is obvious it has been washed, but in time may make it harsh and brittle. Olive oil may be rubbed into the scalp as a preliminary. The water should be soft or softened. After the first thorough washing, the water should be changed, and the hair washed a second time with soap, then rinsed free of all soap. A bath spray gives the best

results in rinsing. The water used to wash the hair should not be too hot, and at the end a short spray with very cold water is beneficial unless the hair is inclined to be "oily."

Hair should be thoroughly dried, and not as rapidly (by intense heat) as to bake out the moisture from within the hair itself, but only that on the hair. The scalp especially should be dried. A damp scalp favors bacterial growth. The hair may best be dried by towels and vigorous rubbing. Driers that produce moderate heat and a breeze are useful. Radiators are usually too hot for this purpose. One should not wrap the wet head in a towel and go to bed with it so. Nor should one dry it by curling it on an iron.

If a shampoo is improperly done, it may make dry hair drier (by washing away sebum), and oily hair oilier (by stimulation of sebum). A well-chosen method should tend to counteract either defect in the secretion of sebum. There is no danger in washing the hair in any weather, providing it is thoroughly dried before going out, and as long before as possible. There is also no danger in washing the hair in any ordinary state of health, although it would be wiser not to wash it when suffering from illness, such as a cold. The only effect on health that washing the hair during menstruation could possibly have would be that of chilling, due to incomplete drying of the hair and the scalp before exposure to cold.

From the point of view of the health of the scalp, there is everything to be said in favor of short hair. It is more easily and more frequently washed, and is better sunned and ventilated and more often brushed. Long hair may be kept clean, however, with a little more effort.

The daily care of the hair should include thorough brushing to remove all accumulated dust and dirt, to remove dandruff if present, and to distribute sebum. A stiff brush goes through thick hair better than a soft one, but it should not be so stiff or be struck against the scalp so hard as to cause injury and possible infection. The scalp should be brushed, however, by parting the hair in various ways. The circulation is stimulated thus. The brush should be kept clean by washing it in an ammonia solution, and then drying it outside in the sun. It is thought that dandruff may persist because of re-inocula-

tion from one's own dirty brushes and combs. When not in use, the brush should be kept out of the way of dust. Brushing does not cause the hair to fall. It pulls out many hairs, but only those ready to fall and to give place to new ones. The comb should be not so fine as to tear at tangles and break the hairs. For long hair a very coarse comb is better. It should be certain that there are no rough spots at the bases of the teeth, in which hair may catch. If there are, the comb should be discarded. There is no objection to use of water on brush or comb if the hair is not made too wet to dry quickly.

Rubbing the hair with dry towels is especially desirable after unusual exposure to dust. Powders rubbed into the hair should not be rubbed into the scalp, and should be thoroughly brushed out in order to accomplish their cleansing purpose.

Massage of the scalp is to promote circulation and hair growth and to distribute sebum or remove accumulations of it. The scalp should be rather movable, and massage should involve not merely rubbing of the scalp, but moving it about. The hands should be clean and the hair first brushed clean. Tonics are of value largely because they encourage massage. The finger tips are the most suitable agents for scalp massage.

If the hair is done up tightly on the head, and the hat worn much of the time, the hair may get very little air and sun. Even short hair may suffer from the same causes if a hat is worn a good deal. There is no reason for wearing hats except for convention, and for occasional protection against too hot sun, too cold wind, rain or snow. The hair should not be covered at night, even by a net to hold a marcel in place.

The effect of curling and waving depends on the degree of heat used. Only the hair that is already grown out is injured, at worst. The quality of the next growth will not be affected. The same is true of permanent waving. Permanent waving may or may not be injurious to the hair that is already grown, the result depending somewhat upon the solutions used before the heat is applied, and somewhat upon the method of heating. If a given method leaves the hair dry and brittle, it should be abandoned.

Animal parasites on the scalp are not uncommon even among the clean. If one person in a group is afflicted, others

are likely to be. If there is itching of the scalp, an investigation should be made for lice. They may be readily destroyed by suitable methods prescribed by a physician. Occasionally swelling of the glands in the neck may be associated with the irritation of the scalp so caused.

When exposed to the coughing and sneezing of those with communicable disease, the hair may be contaminated by bacteria, from which source they may later be taken into the mouth or nose on the hands. After communicable disease or exposure to it, a thorough cleansing of the hair should be included with the other cleansing of the body.

The eyelashes and eyebrows are usually similar in character to the hair. If the hair tends to grow thick and long, these other hair structures are likely to do so also. They are generally of the same color as the hair. If the hair is dyed, the discrepancy is usually apparent between its color and that of the brows and lashes. The lashes cannot be dyed with safety to the eye. Gumming the ends of them also entails danger to the eye and the lids. Cutting them seems to produce no tendency for them to grow out longer. Nothing can be put on them to make them grow. The lid margins are to be kept clean, as they will be in the usual thorough washing of the face. The lids may be denuded of lashes if they are infected. The mere swelling of the lids and the congestion produced by eye strain may result in enough pressure on the hair follicles to kill them. Thinning of the lashes may thus be associated with eye strain. After a stye is healed, it may be found that there is an area without lashes, from which they may or may not grow again.

The eyebrows have a definite length and width. The practice of cutting them, or pulling out some of the hairs, to make them narrower or shorter, is of questionable aesthetic value, since the original line of the hair, as it grows from the skin, is plainly visible. If the brows meet over the nose, a few of the hairs may be removed by the electric needle. Skin diseases, as eczema or syphilis, sometimes cause brows and lashes to be lost entirely.

The care of the skin and the hair is often prescribed by those who are not physicians, although it is a physiological matter.

Those advertising as beauty specialists are usually individuals who have had no medical training, and apply measures for the care of the skin that are necessarily based on surface observations only. In the case of some of them, experience has taught them a good deal about the care of the skin, and their work is often successful in so far as it could be successful without a diagnosis of the skin condition. Some of them have reputations to maintain and cannot afford to take many chances. On the other hand, many of them are willing to sell almost any form of treatment to anybody. Dermatologists often find that among their most difficult cases are those that have spent much money in the unscientific and expensive search for help from sources from which help could not be legitimately expected. The hygiene of the skin is as dependent on physiological principles as is the hygiene of any other part of the body.

CHAPTER XLI

THE MOUTH AND TEETH

The care of the mouth is made particularly necessary because the mouth is the entrance both into the respiratory tract and the alimentary tract. It is particularly important to keep it free from infection. Except for the teeth and gums, the tissues of the mouth are quite resistant to infection. These structures, however, require a good deal of care to keep them sound, and to prevent the remote damage that is likely to follow their disease.

The teeth become unsound for many reasons. It is thought that some individuals inherit poor tooth structure, and it is certain that teeth often become potentially non-resistant during the period before birth. Even those who have no hereditary or congenital tendencies to poor teeth may acquire them, however, during early life. In any case, the defect that renders teeth most susceptible to damage is the failure of mineral deposit in the teeth, which is often associated with a similar defect in bone formation.

The congenital conditions that lead to poor teeth are largely those associated with faulty diet of the mother. Both bones and teeth, or only the teeth may suffer. The diet that produces such results is defective, probably, not only in respect to lime, but in respect to vitamins that enable lime to be utilized.

Acquired poor teeth are due to a similar faulty diet on the part of the individual himself. The significance of diet in influencing tooth formation and preservation is now fully recognized. At any time in life a faulty diet may quickly show effects in the teeth. Experiments have been done on growing guinea pigs, giving them alternately a good diet and a poor one. It is possible thus to produce alternate rings of sound enamel and of impaired enamel on the erupting teeth.

If the diet is satisfactory all along, very little care of the teeth is necessary to keep them sound. It is even possible to neglect them entirely, as is the case in peasants of some races, without damaging them at all, if the diet is such as to give them good resistance. Solutions of sugar and bacteria may even be experimentally allowed to adhere to the teeth without producing caries (decay) in such resistant teeth. Very few individuals, however, seem to be equipped with teeth that need no care. In addition to the regulation of the diet, considerable local care is needed to keep the mouth and teeth clean.

Lack of personal care, and of care by dentists, results in caries being found more frequently as a rule among the ignorant and the poor, although free dental facilities and popular education have made good teeth not by any means so rare as in the previous generation. In fact, it is noticeable in all classes that the teeth of the present generation tend to remain sound longer than did those of the previous generation. Dental hygiene is a branch of hygiene that has been given more attention than some other equally important aspects of living. It is by all odds better understood popularly than is the hygiene of sleep and rest, for example. It is not unusual in groups of children from 10 to 14 years of age to find 10 per cent who have never had a cavity. In some college groups the percentage is almost as high. This means inevitably that diet has become more suitable, and that local care of the teeth has been improved.

In addition to the harm done to the teeth by faulty lime deposit and by lack of cleanliness, teeth may be at fault in other ways. Imperfect occlusion of the teeth seems to be fully as common as ever. By this term is meant the failure of the two sets of teeth to meet exactly at all the biting and chewing points. Sometimes the back teeth meet and the front teeth remain separated, or the teeth on one side meet while the others do not. A common defect is narrowing of the jaw so that the front teeth protrude. Faulty "bite" of this type is often due to the narrowing and arching of the palate as a sequence of adenoids and mouth breathing. Needless to say, adenoids should be detected and removed before this anatomical deformity arises. Even if the adenoids disappear without

operative measures, they may have already caused a deformed jaw and malplaced teeth. Such dental deformities are corrected by the use of appliances—"bands"—to widen the jaw and to allow the teeth to occupy their normal position. The treatment is best begun at the earliest moment when the deformity is noted, although up to fourteen years of age, or even later, some improvement may be made by the services of the specialist in orthodontia, as such dentists are called. At any time during life, if a second tooth must be extracted, unless it is at the end of the jaw, its place should be filled by something to hold the other teeth in their proper position (a brace between the teeth or an artificial tooth).

Irregularity in spacing of teeth and narrowing of the jaw may result from premature extraction of the first teeth. They should be allowed to remain until they practically drop out of their own accord, for two reasons: first, because the nutrition of the second teeth is improved by the presence of the first teeth until the last possible moment; second, because they serve to hold open a space sufficient for the second teeth, so that irregularity and cramping does not result. It is particularly hazardous to remove the first, or six-year, molars, that appear before the first set of teeth are lost. Parents often consider these the last of the first set, instead of the first molar of the second set, and give them little care, allow them to decay and have them removed. Then the alveolar process of the maxillary bone, into which the tooth was set, is no longer needed, and is absorbed, and the jaw becomes smaller. The occlusion lacks the most important pivotal tooth when it lacks the first molar. It is important for the nutrition and placing of the permanent teeth that the first set be given as much care as the others.

The harm of faulty occlusion is both aesthetic and hygienic. Teeth that do not meet and act in chewing do not have adequate circulation about them, and easily decay. Moreover, their attachment in the jaw and to the gum becomes loosened, often giving inflammation of the gums about unused teeth.

The occurrence of disease, especially in childhood, may interfere with general nutrition to such a degree as to make the teeth less sound. Those teeth that are forming during an

attack of illness may be much less sound than those formed during good health. In fact, the whole set of teeth may be influenced by more or less continued ill health in childhood. It is chiefly the enamel that suffers thus. Poor enamel offers a focus for bacteria and decay. It has been thought that certain medication (e.g. iron) during illness was responsible for injury to the teeth. Now it is thought that it is usually the illness itself, rather than the iron, that is responsible for injury to enamel appearing at such times.

Finally, teeth may be injured by trauma (mechanical damage). If the teeth are used to bite too hard objects, even candy, the enamel is likely to be cracked. In such cracks in

A B

FIG. 250.—Sound tooth, A. Carious tooth, B.

the enamel, bacteria collect, and from there penetrate to the more easily infected interior of the tooth. If a blow causes a tooth to crack or break or loosen, the tooth should receive immediate dental attention. If not, the involvement of the nerve may follow, the tooth die and become discolored.

The forms of mouth disease that are most common are caries of the teeth, and gingivitis or inflammation of the gums. Pyorrhoea (which means the flow of pus) is a form of gingivitis dependent on pus germs locally, and predisposed to by many factors.

Caries means decay of one or more layers of tooth substance, and the final extension to the pulp of the tooth or its nerve substance. The break in the enamel comes first. If small superficial breaks are repaired at once, no further damage results, but the delay in repair allows food remains to decom-

pose in the openings in the enamel and bacterial activity to commence. Even without a definite break in the enamel, if it is thin and non-resistant, a collection of food debris lying in contact with it is enough to erode it in time. Both the nature of the enamel and its degree of resistance, and the chemical reaction of the salivary secretion, which in some circumstances favors decay, are influenced to a considerable degree by diet and body metabolism generally.

Cavities are particularly likely to form in crevices in the molars, and in the spaces between any teeth, especially if the teeth happen to be so placed that material can get wedged between them but not so easily get out again. The first molars, for the reason already given, are the most likely to be

FIG. 251.—Impacted third molar, or "wisdom tooth."

carious. Next in order of frequency of decay come the third molars or "wisdom" teeth, which are so far back in the mouth that they often fail to be thoroughly cleaned. The third molars are more likely than the other teeth to erupt at an angle. Sometimes they are wedged (impacted) so that they cannot erupt, and must be removed by operation if they cause trouble. While impacted within the jaw they may become the seat of infection.

Gingivitis, or inflammation of the gums, comes from several causes. It is thought that it is most commonly due to mechanical conditions that arise as a result of the way in which the teeth are arranged in the mouth. It will be recalled that the root of each tooth fits into a socket of the jaw bone, and that,

extending upward a short distance around each tooth at its base, is a prolongation of the tissues covering the jaw bone, known as the gum. The gum adheres to the surface of the tooth normally, but may readily become loosened and even infected at its margin. The mechanism is rather unsatisfactory, unless conditions are favorable for keeping this union firm. Ordinarily in chewing the circulation through the gums is increased, and their health promoted thereby. If a tooth is not used in chewing, the gum may be undernourished, and suffer accordingly. If one tooth receives too hard blows, especially if it is hit at an angle, the gum may constantly be pushed away from the tooth, and become irritated. Both failure to use a tooth for chewing, and using it at a disadvantageous angle are likely to be the result of faulty placement of the teeth. The possibility of later damage to the gums gives an additional reason for the regulation, early in life, of irregular teeth. A single filling, unskilfully placed, may, however, cause the "bite" to be injurious to some portion of the gums. It is thought that the health of the gums largely depends on the ability to use all the teeth at the proper angles in chewing, and also upon the actual use that is given them in the correct position.

Gingivitis is also frequently due to the irritation of the gums by the accumulation at the gum margins of the teeth of a solid or semi-solid substance called tartar. This is composed of salts deposited from the food and the saliva, together with bacteria. It is more likely to form on the inside of the teeth where they are not so carefully brushed. It is thought that the saliva in some cases is, because of the diet, particularly likely to cause such deposits. But it may be kept from forming by following a dentist's advice regarding the care of the teeth. It is important to prevent it because it harms the teeth and is irritating to the gums, causing them to become red, soft and spongy, or to recede and become thinned.

Gingivitis is sometimes found in a clean mouth, but is far more likely in an uncared-for one. Accidental infection with special kinds of bacteria may give an acute inflammation that is curable, leaving the gums normal again. The organisms that in the army caused trench mouth are also present among

civilians, giving a disease known as Vincent's angina, that is often limited to the gums. It is a highly infectious condition that may spread from person to person among those in close association. Any redness and bleeding of the gums should be promptly investigated. If microscopic examination of the material about the gums shows Vincent's organism to be present, the individual must take special precautions not to infect others. Sometimes the organisms spread from the gums to the tongue and throat and cause severe inflammation there, but this is less common ordinarily than it was during the war.

It is possible to injure the gums while using dental floss between the teeth or even with a tooth brush that is too hard, so that they become inflamed, and recede, and become more easily infected.

Pyorrhoea, or suppurating infection of the gums, is a common ailment, although less so than advertisements would lead one to suppose. It is associated with lack of care of the mouth, but is particularly common in some constitutional diseases, such as diabetes. Even those who take the most meticulous care of the mouth may be affected. It always needs the attention of an expert dentist, preferably one specializing in this particular branch of oral hygiene. There is no tooth paste or powder having specific power to prevent it. Each case needs individual study. It should be attended to early, as the soft, receding, infected gums fail to hold the teeth in place, and they may become loose and have to be extracted.

There are many aesthetic arguments for the care of the teeth. The matter of appearance is obvious, but no less important is the offensive odor produced by a foul mouth. Bad breath is most often due to this cause, although it may also be due to decomposition in the intestinal tract, or to the presence of diseased tonsils, or to infection of a chronic sort in the nasal passages (called by laymen, catarrh).

There are also economic reasons for the care of the teeth. It is less costly to give the teeth personal attention and to have repair work done as soon as the need for it is noticed. If one waits until the dentist's services are badly needed, it is not only expensive but usually also uncomfortable to some degree, and the aggregate of time thus consumed may be more than

would have been spent on the daily care of the teeth. Finally, the results of repair never are quite so satisfactory as the results of care.

Aside from the destruction of the integrity of the tooth itself, and the pain involved in the decay process and in that of having it treated, more serious results may follow. Infection may begin at the deep-lying apex of a tooth and the tooth die. After its nerve is dead, the length of time a tooth may remain in the mouth is usually limited. One must usually dispense with it sooner or later, because infection is very likely to establish itself there later, even if none was present at the time the nerve was destroyed.

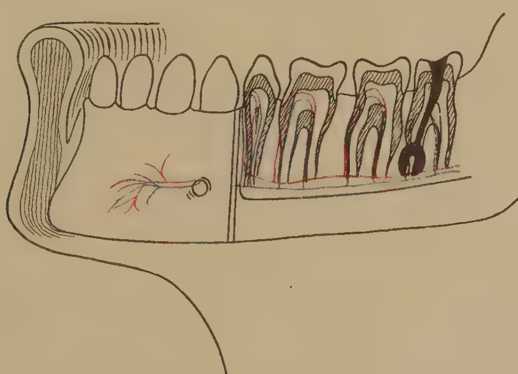


FIG. 252.—Abscess at the apex of a carious tooth, showing route of absorption into the circulation of the infective material or toxins.

The condition known as apical, or root, abscess may appear in a sound tooth or one showing very little decay. It occurs chiefly in devitalized teeth, however. The pulp of the tooth contains blood vessels and nerves. When these are destroyed gases form, which causes the pain associated with abscessed teeth. The bubbling of the gas provides the means for forcing infective material through the canal to the jaw. Unfortunately pain does not always occur in sufficient amount to call attention to what is happening until perhaps the jaw bone is involved in the infection. Sometimes swelling of the face may be the only indication of the damage taking place.

All teeth that are known to have died or to have had their nerves killed by the dentist should be watched carefully for any indication of infection, whether they seem sound or not. Teeth that have been "crowned" need especially watchful care. An X-ray examination of all such teeth should be done at least once a year.

The local damage, although serious enough, is not half as important as the remote damage that is possible from infected teeth. The teeth share with the tonsils the position at the head of the list as foci of remote infection. The bacteria may travel from the teeth by means of the blood stream or the lymphatic vessels. If they travel by the blood stream, the joints and heart and kidney seem most likely to be damaged; if by the lymphatic stream, the glands of the neck may enlarge and suppurate.

Bacteria from a foul mouth may also be carried into the system by being swallowed with food, or breathed into the respiratory tract on the breath, or by being taken up by the tonsil. It is probable that the thyroid gland sometimes becomes infected as a result of mouth infection. The eye, it is known, may become diseased as a result of diseased teeth. The nasal sinuses in the jaw bone may be involved in abscess of upper teeth whose roots sometimes extend into them. Whether or not bacteria from teeth localize themselves elsewhere in the body, and cause serious damage there, the poisons may be absorbed and give anemia and general lack of health and vigor.

It is undeniably hard to keep the teeth absolutely clean. Thirty-two different structures set near together, surrounded by soft tissues adherent to them at the margins, offer some difficulties. But the teeth may usually be made to last a lifetime if cared for from the beginning, providing they were not potentially defective at birth.

The first essential in the care of the teeth is, as has been mentioned, the care of the diet, so that it shall include enough vitamines and minerals. The second essential is the avoidance of mechanical injury to teeth or gums. One should not bite too hard substances, or use hard substances to remove particles of food between the teeth. The gums in particular

should not be injured by using too stiff a brush, or by brushing toward the gum, or by cutting them or pushing them away from the teeth by the rough use of dental floss. Dental floss should be pressed gently between the teeth, both ends then brought to the outer side of the tooth, and the floss removed by pulling both ends outward rather than upward or downward. Correct occlusion has been mentioned as of great importance in avoiding mechanical injury to the gums in particular.

The third essential is to avoid chemical and bacterial injury. This is best accomplished by keeping the surfaces of the teeth smooth and shining, so that no food particles can catch on them, and by taking all precautions against leaving any food remains in the mouth after eating. The sides of the teeth next the tongue are less likely to be brushed well than those next the cheek, although they need as much attention. The use of dental floss to clean between the teeth is often, although not always necessary. If the spacing of the teeth is unusually wide, a brush may be all that is needed.

The toothbrush should not be too large, nor too stiff, and should be curved to fit the teeth, having longer bristles at the end, to brush behind the last teeth in the jaw. A somewhat rotary motion is advised, to prevent irritating the gums. The brush should be kept clean by occasional washing in strong soap suds or ammonia water and drying in the sun. Always, after using, it should be rinsed in hot water and kept in a place where it will not be handled by others, or contaminated by dust, or in contact with others' brushes. After an infection the brush should either be most thoroughly cleaned or cast aside, as any remaining bacteria may cause a reinfection. The mouth always needs special care during any infection.

There is no good substitute for the bristle brush. The use of small pieces of gauze to rub the teeth to a polish necessitates putting the fingers in the mouth, which is undesirable unless the finger is very clean and entirely wrapped in gauze. Dental floss also should be used so that the fingers, even supposedly clean ones, do not come in contact with mouth surfaces more than necessary. Brushing of the teeth is recommended after each meal, on retiring, and before breakfast. In spite of ade-

quate daily care, the teeth will often be found to need cleaning at least once a year by a dentist.

As has been suggested, some individuals get along very well without so much cleaning of the teeth. They are the ones who sometimes say that a tooth brush is not necessary, and that the somewhat brush-like surface of the tongue may be substituted as a means of polishing the teeth. The teeth of most individuals would be in a bad state in a short time if they relied on such a measure.

On the brush may be used any of the standard tooth powders or tooth pastes. These have, as a rule, little value as antiseptics, and need not be chosen with that in view. Their virtue lies in the mechanical polishing of the teeth, for which purpose they contain an amount of gritty substance, usually powdered chalk, that polishes but does not scratch the enamel. Whatever powder or paste is used, it should not be too gritty and should be thoroughly rinsed away. Soap may be used to clean the teeth for one or two of the daily cleansings, but it is too smooth to be relied on entirely. Sometimes salt is used for cleaning the teeth. It is, however, too drying to normal gums. The acid of fruits at the end of a meal has been advocated in order to break up sticky food debris, and to stimulate the flow of saliva. In this way it aids in cleaning the teeth, but the teeth should always be either rinsed or cleaned afterward in order to remove the excess acid.

Mouth washes for rinsing the mouth after cleaning the teeth may be mildly antiseptic or may be of such character as to counteract mouth acidity, or may be such as are specially recommended for the individual by his dentist for their effect on the teeth and the gums (e.g. lime water). There are many mild antiseptic mouth washes, some very good ones being widely advertised. They should not be used, however, in the hope of masking odors. The cause of the odor should be found and removed.

The health of the teeth and the gums is greatly aided by the eating of food that requires chewing. The vascular membranes about the teeth need this stimulation to keep them healthy. Moreover, the flow of saliva is increased, which is good for the teeth. There is usually greater susceptibility to

caries in a dry mouth. It is not necessary, however, to use other substances than food to get the desirable results of chewing.

Dental inspection should be had at regular intervals, in order to make sure that no trouble has arisen, and if it has, unknown to the individual, to have it corrected at the earliest moment. If such inspection were done twice a year from the second year on, the life of the teeth would be greatly increased. If one gives the dentist a fair chance, one may escape with the use only of the mirror and the polishing wheel, at the bi-annual visits. Needless to say, no obvious defect should be ignored a moment longer than necessary.

CHAPTER XLII

THE HYGIENE OF THE NERVOUS SYSTEM: MENTAL HYGIENE

The care of the nervous system involves the prevention of damage to the structures that compose it, and of faulty functioning of these structures. In no system of the body is faulty behavior without structural damage so frequently found as in the nervous system. There are many functional nervous diseases.

Structural damage of the nervous system is brought about by the usual causes of disease, and may be either hereditary, congenital or acquired. The nervous system is more liable than some of the other systems to be hereditarily defective. It has recently been noted, however, that some of the cases that were formerly considered due to defective nerve tissue may be due to defective functioning of the endocrine glands, which may profoundly affect the nervous system in its functioning. Whatever the signs of nervous malfunction the first step should always be a diagnosis of their cause.

The acquired forms of organic nervous disease include, first, infection. There are two types of very serious disease of the nervous system that may occur in the later stage of syphilis, each of which actually destroys nerve cells of either the brain or the spinal cord. One of these diseases involves a very marked disturbance of the motor system (locomotor ataxia), and the other constitutes one of the forms of mental disease (paresis).

Other infections may attack the nervous system and affect its structure, as well as its functions. Encephalitis lethargica —"sleeping sickness"—is an infection of the brain. Meningitis is the infection of the coverings of the brain and the spinal cord. The after-effects of such infections may be any degree of interference with brain activity, motor function or sensation.

Neuritis is the term applied to inflammation of nerves. It should be distinguished from neuralgia, which merely means pain in nerves, often without any organic cause. Neuritis is due sometimes to infection, and sometimes to the effect of pressure or of poisons.

Poisons constitute the second main cause of organic disease of the nervous system. There are several poisons capable of damaging the nervous system structurally. One of them is alcohol. Many poisons produce changes in function, without harming the tissue itself.

The symptoms produced by disease of the nervous system are disturbance of its functions, which are those of the brain, and of the affector and effector nerves. All may be disturbed without organic disease in the nervous system, however. Blindness may be due to defect in the eye itself; and paralysis or weakness in muscles may be due to defects in the muscles. On the other hand all of the organs may be sound and the nervous system itself sound, and yet some of its functions be poorly performed. Just as the function of the stomach, for example, may be completely disordered when affected by the sensations due to the motion of a rocking boat, so may it be completely disordered if it is affected by some other sorts of unusual nerve impulses.

Nerve impulses that are ineffective or unsuitable for the orderly performance of body functions (i.e. that give functional nervous disease) result from a number of different causes. Chief among these are inadequate nutrition of the nerve cells, overstrain and fatigue of the cells, the temporary effect of poisons, and, finally, disturbed emotional states.

The nutritional needs of the nervous system are parallel to those of the body as a whole. Nutrition is not here used in the narrow sense of adequate food intake, but in the wider sense that implies adequate distribution to every cell of the body, by means of the circulation, of material for the maintenance of cell structure and for the energy use of the cell. It involves also the complete removal of cell waste. The nutrition of the cells cannot be maintained even on an adequate diet and an adequate circulation, if they are called upon for excessive work. Katabolism will be too greatly in excess of

anabolism. Therefore the hygiene of the nervous system implies not only adequate food intake and an adequate circulation, but also the regulation of the work done and the rest taken, so that the cells shall not be interfered with by fatigue.

Fatigue acts in two ways: first, the nerve cells undergo shrinkage and change in molecular structure due to their activity; second, they are clogged by the chemical fatigue products that are produced in them as in all other organs. From these effects they entirely recover after an adequate rest. Such effects do not represent actual disease or permanent structural change, although the results of too great strain might be serious to the body because of the impaired function of the organs whose nerve supply was hampered.

Fig. 253.—Cells of the spinal cord at rest (*a*); after activity (*b*). Note change in size of nucleus and in granular structure.

If the degree of disturbance is less pronounced, but continues over a long period, the period of rest necessary for recovery may be proportionately long. Ordinarily the damage caused by a moderate degree of overfatigue may be righted without having to devote one's self entirely to resting.

While the nervous system is affected by fatigue, the effects are quite generally exhibited in the physical, mental and emotional spheres. This may be because there is lowered resistance at the synapses, so that incoming stimuli pass easily across to effector neurones. What may be the case when it is said that a person is "nervous" is that the synapses offer less resistance. Such a person jumps at slight sounds, runs a rapid pulse when excited, weeps at slight provocation, and generally makes quick responses that are more intense than need be.

This effect on the nervous system is very commonly due to fatigue, but it may also be due to other toxins. All stimulant drugs are stimulants because they lower synaptic resistance. The narcotics, however, have exactly the opposite effect. An

excess of secretion of certain of the endocrine glands has the effect of lowering resistance to stimuli, and making the individual "nervous." Other endocrine conditions may, however, have exactly the opposite effect, causing a lethargic state.

Whether by affecting synapses or not, fatigue markedly affects the relationship between incoming and outgoing nerve stimuli, so that action follows sensation either more or less readily than normally. When sleep comes on, for example, there is less ready transfer of both kinds of impulses; sensations are less readily perceived, and action less readily produced. The effect is similar to that of the narcotic drugs.

Other toxins produced in the body may have as pronounced effects as those of fatigue. Among these may be mentioned the toxins of decomposition in the intestinal tract, and the toxins of bacteria, either in acute illness or from chronic foci.

The disturbance of function of the nervous system, it will be seen, is no less important than the disease of its tissue, for if the nervous system is not serving its purpose of supplying proper stimuli for the regulation of the body processes the result is as bad a though it were so damaged that it could not do so. In a given instance, for practical purposes in living, it hardly matters whether an organ cannot work well, or merely is not working well. This is particularly true of the nerve tissue, since so much depends on each organ and cell being activated to exactly the right degree, no more and no less. The symptoms mentioned as signs of nervousness are of relatively slight importance in comparison with the disturbance of organ activity that usually accompanies it. A stable and efficient nervous system is essential to a stable and efficient body.

One of the important aspects of the hygiene of the nervous system is that of training it to perform its integrating and regulative functions easily and efficiently. One characteristic of nerve action must be understood in order to understand how this may be best accomplished—the tendency of nerve impulses to pass over synapses that have been utilized in response to the same stimulus before. Living may be greatly simplified by cultivating such spontaneously appearing responses to stimuli that frequently occur and that should be

responded to in given ways. If good habits are not established, some other sort are likely to be. If none are established the individual has to use his conscious mind to decide what to do on each and every occasion—which is a waste of thought. There are many habits in the daily life that the nervous system may be trained to adopt for the purpose of sparing one's self the necessity for the use of conscious attention. They involve not only the physical health but the general conduct of life.

Among those of particular health significance may be mentioned those that deal with eating and elimination, and with hours of work and sleep; and those that serve to protect one's self from contact infection, and that protect others from one's self when infected. The unguarded sneeze ought to be an impossibility because of firmly fixed habits to the contrary. It ought to be almost impossible to eat irregularly, or to fail to go to sleep upon going to bed. There are many more or less established and universal habits that the nervous system should be trained to perform automatically. So far as may be, the direction of the personal health should be made a matter of habit, after one has learned the measures that are the most successful in maintaining his health.

Whether or not one can succeed in training the nervous system in conducting the life on the basis of good habits, at least one should prevent it from developing strong bad habits that make wise voluntary choices difficult.

Another aspect of the training of the nervous system involves its training in the neuro-muscular coördinations that are a part of everyday life. The development of skill in any act is as much due to the training of the nerves as of the muscles themselves. Since this is so, one can expect, for example, to have good technique in body mechanics as a result of the same tendency of the nerves to become fixed in the habit of responding in given ways to given stimuli.

MENTAL HYGIENE

Whereas physical hygiene is primarily for increasing the span of life, and the fitness of the body to partake of a full life, mental hygiene is primarily for the purpose of enriching life.

Given a sound body, capable of living fully, the mental state determines what the actual content of life is—whether it is agreeable and valuable to the individual and to others, or whether it is a source of misery and futility. The improvement of the content of life must usually be based on physical health; but given that as a basis, it depends finally on the mental health.

Bodily conditions influence the mental health in pronounced ways at times. Certain bodily diseases—notably chronic alcoholism and syphilis—cause some of the most serious mental diseases. Many malfunctions of the body are the cause of mental malfunctions also. It has been mentioned that there is a relationship between malfunction of the endocrine glands, for example, and the state of mind and the type of personality. Even minor degrees of disturbance in physical condition are often reflected in changes of mood. General bodily fatigue, for example, often produces quite marked mental changes. The pessimism and the irritability of the weary are proverbial. No less marked is the effect of conditions in the digestive tract. The complacent after-dinner mood bears testimony to the mental effect of allaying the pangs of hunger.

Yet close as is the relationship between mind and body, it must be stated quite definitely that not all states of mind have discernible causes in physical conditions. With a body that is, so far as may be determined, in exactly the same state, the mental state may vary, for example, from exaltation to depression within a few hours. This is because the mental life is the product of the body, much as sound is the product of the musical instrument; and is, in the same way, subject to laws of its own. Music depends on the musical instrument, as the mental life does upon the body; but the same musical instrument, if skilfully played, gives forth a sort of music entirely different from that given forth when it is played by an amateur. Although body and mind are not identical, neither are they separate. As has been stated, it is generally thought at the present time that the mind is the product of the whole body. Formerly it was thought that the mind was the product exclusively of the brain. This idea is no longer held.

The mind may be defined as the sum of all the motives that produce conduct, and of all the feelings and emotions that surround these motives. If this definition is to be accepted, it is necessary, first, to consider what the motives are that produce conduct. Most familiar, of course, are the conscious motives, those that result from cerebral, or brain, activity. These are the only motives that individuals commonly recognize as influencing them. Yet a more discriminating observation of the causes for action would disclose the fact that many acts are performed without any conscious willing, in fact even against one's intention. If one falls asleep over his book, for example, he may be quite truthful in saying that he tried not to do so. It is plain that the body has motives of its own. These are exhibited chiefly as the cause of reflex action. All of the organs of the body carry on their work in a way that appears mechanical, and yet since the maintenance of the body is the end sought in the reflex adaptations among organs, the organs may be said to have motives.

To distinguish such motives for action as appear to underlie reflexes from those that underlie consciously deliberated action, the former may be called unconscious motives. The largest group of the unconscious motives consists of those that are founded on instinct. It will be recalled that, in speaking of the ways in which action is produced, it was asserted that instinct is the most fundamental activating force. Its motives are intrinsically the most powerful ones that underlie action, and the most frequently in operation. The conscious motives on the whole are far less prominent. Surely motives of so great importance must be given a place in the constitution of the mind. It is logical to consider the instincts, in fact, as the very foundation of the mind.

It is not easy to learn to consider the mind in this inclusive way, after having thought of it as a product of the brain only. It is hard to think of the mind as other than the conscious mind; and to give up the use of the term motive to describe only the conscious motives. Yet the facts seem to make it necessary that one do so, if there is to be a clear concept of the nature of the mental life. The word motive implies a force that incites to action. Obviously the body acts on other bases

than conscious willing. The body may be said therefore to have other than conscious motives. The behavior of the body is purposeful, whether consciously so or not. Whenever action takes place, it is because there is something to be accomplished. The sum of all that is accomplished is the life of the individual, and the sum of all that activates it is the Mind of the individual, according to the definition given.

All the varieties of motives are necessary, none more than the others. Supreme as the conscious motives seem to be, they would not suffice, perhaps even for a day, in the absence of the motives represented by the instincts, or the motives represented by the reflexes, producing their quick, unconscious adaptations. It is difficult to imagine how man would conduct his life without the powerful motivating force implied in the instinct of self-preservation, for example. Animals that have very inferior brains and carry on little cerebral activity are able to survive because of the guidance by instinct. Man himself could not do without instinct. Yet it is the conscious motives that distinguish man from animals, and that are able, if they are used in coöperation with the other motives, to bring about in man the most perfect type of adaptation to the conditions of living. If all the motives are suitably utilized and harmonized, the result is not only effective action, but the comfort and happiness that is quite as important in mental health.

It will be recalled that in the definition of the mind it was stated that the mind consists not only of motives but of emotions. Emotions of various sorts are the inevitable concomitant of the motives and of the action they produce. Those that surround the instincts in particular are inclined to be rather strong. When instinctive motives are acted upon, pleasure and satisfaction tend to result. Conversely, when instinct is thwarted, discomfort and unhappiness tend to result. The reason that acting upon instinct is pleasurable is that the instincts have as their aim the preservation of the self and of the race. From the foregoing statements it might be concluded that a happy life depended upon a complete conformity to the dictates of instinct. Probably this would be true were it not for the fact that man possesses a conscious mind presenting motives that also demand action. By means

of the conscious mind, man is capable of surveying situations from many points of view, and of reaching conclusions based on the consideration of many facts. The reality that he perceives may draw him in a direction exactly the opposite of that in which instinct draws him. Furthermore, happiness or unhappiness follow in the trail of acting upon or thwarting the conscious motives. It might just as rationally be concluded that only the conscious motives should be followed if man is to be happy and contented, as that only the instinctive ones should be followed. But this is no more true in the one case than in the other.

It is obvious early in life that the presence of many different motives leads to mental conflict, and that as long as the conflict lasts peace of mind is lacking. The most obscure conflicts are those that take place between two entirely unconscious wishes. Many of man's conflicts go on quite unknown to him, or he is only vaguely aware of them. What he is aware of in such a case is the feeling of distress before they are settled and the satisfaction when one motive has won an unequivocal victory. An unconscious wish, for example, to be held in high esteem socially may conflict with another unconscious wish to do that which would lower one's social standing. Sometimes the conflict is between a known motive and another of which one is unaware. For example, the conscious wish to go forth into the world and to do battle with it may conflict with an unconscious wish to remain safe and protected in the family circle. Sometimes the whole conflict is between two thoroughly recognized warring claimants of the field and the victory. A man may wish for wealth on the one hand, and on the other he may wish to engage in a career in which there is no possibility of attaining wealth. If there is too much conflict the individual is both unhappy and inefficient in dealing with life. He therefore seeks by some means to keep peace between his often conflicting motives. Unless a solution is found, the conflict goes on and the individual continues to be perpetually drawn this way and that, as one motive or the other dominates. Such a state of affairs is at the root of much mental disease and mental malfunction. The outcome often is the total suppression of one of the motives, the individ-

ual acting on and gaining satisfaction from only one of them. This, too, often leads to mental disease. Mental health involves acting upon all motives that are acceptable to the personality, utilizing them all in suitable ways so as to satisfy them.

All sorts of compromises may be made between two motives. Sometimes they are made consciously and sometimes unconsciously. Sometimes they are successful and sometimes not. Very often the unconscious compromises are not successful in producing mental health, although they may satisfy the individual. Unconsciously adopted measures designed to gain the feeling of ease and satisfaction that comes from absence of conflict between motives are responsible for many of the unfortunate personality traits that characterise the neurotic. Every individual, even the most normal, frequently makes use of such measures. For example, if duty bids a man do one thing and pleasure bids him do another thing, he may quite unwittingly forget the unpleasant task. It is quite certain that such forgetting is not always merely chance, but that in many cases it is due to the fact that a part of the mind had the deliberate purpose of forgetting, in order to free the individual at once, not only of responsibility, but of any consideration of conflicting motives. Although an incident of this sort might occur repeatedly without in any way endangering the mental health, it is typical of the sort of solutions that are on the whole unsatisfactory and that should be guarded against.

The devices the mind uses to solve conflicts are very numerous. They come about unconsciously in response to all sorts of disagreeable situations, present or threatening. They may be likened to the adaptations the muscles make to save one from falling. Without any deliberate action on the part of the individual, the muscles tense in one part and relax in another. Because of the similarity to mechanical adjustments, the mind's methods of dealing with impending unpleasantness may be called mental mechanisms. They are manoeuvres that the mind carries out for the individual, to protect him, or defend him, or to compensate him in some way for what would otherwise be unpleasant to him.

Many of the mental mechanisms that are unconsciously used are valuable in securing a better adjustment to one's self and others and to the circumstances. On the whole the unconscious mechanisms are probably as often favorable as unfavorable, just as are the bodily reflexes. Since, however, they cannot be counted on always to be either immediately or ultimately favorable, it becomes necessary to find more reliable ways of solving conflicts between motives. It has been found that the most reliable way involves the use of the conscious mind for the purpose of coördinating motives with life as it really is. Consciousness is capable of being used to make the most satisfactory and agreeable adjustments, but this is not the same as saying that only conscious motives should be followed. The way in which consciousness makes better adjustment possible is not by denying all the claims of instinct, but by harmonizing instinctive desires with the demands of reality. The result is the doing away with a given conflict and the utilizing of all the motives involved in ways that are suitable and that are approved by the whole personality.

It would be a mistake to conclude from the foregoing statements, however, that all that is necessary for satisfactory adaptations and a happy life is a high level of intelligence. The converse is to a certain degree true; those who lack intelligence because they have few or inferior brain cells, are hampered in their adaptations to life by their lack of facility in learning, remembering and reasoning. They cannot have as complete a knowledge of the conditions they have to meet, and will tend to follow instinct on a crude level, and to be governed by feeling.

Having normal intelligence, however, an individual may fail to use it. A man of great brilliance, retaining his brilliance of intellect, may become quite "irrational." Although able to think clearly he has lost the habit of doing so, either in respect to certain matters about which he has very deep feelings, or on all matters. In an extreme case he may, for example, be sure that he has a million dollars, when he actually has not a cent. He wishes he had a million dollars, and "the wish is the father to the thought." His conscious reasoning powers have

become subordinate to his deep-seated, overwhelming feelings. This inability to recognize facts, and the ability to believe the utterly false probably did not come upon him suddenly, however. It is likely that from childhood such a man had been turning away from the real, and believing what he wished to believe.

It is often not at all a question of the degree of intelligence but of the degree to which it is used. It may be used to obtain knowledge of situations as they really exist, and to plan ways of meeting them; or it may fail to be used for this purpose, the individual remaining blind to the realities that confront him, and using his conscious mind only to devise reasons for his irrational behavior. In the case mentioned, the use of the intelligence, had it been possible, would have enabled the individual to recognize his impoverished condition. Instead he holds fast to his emotionally determined belief, the conscious mind yielding its sway before his inner unconscious demand to feel great and rich and important.

Mental health, above all things, depends on the recognition of reality. Mental disease that does not depend on physical disease depends above all else on the evading of reality.

Serious mental disease is a remote danger for most; yet minor degrees of malfunction of the mind are extremely common. Serious mental disease represents, however, only an extreme degree of the common minor malfunctions of the mind —an extreme degree of the use of the protective and defensive mechanisms of the mind that enable one to avoid confronting the truth. The tendency for these bad mental habits to become extreme seems to have some relation to heredity of poor nervous tissue, although this may occur in those whose nervous inheritance is perfectly sound. In either case, the training of childhood and early adult life may act so as to modify hereditary tendencies.

The tests for the soundness of the mental health are not at all like the tests for the intelligence. In estimating mental health it is found that the main difference between those who have it and those who have not, is the difference in the ability to conduct life adequately both from a personal and a social point of view, and to derive comfort from life. Those who

lack mental health make it evident in failure to adjust to life as it really is. They may or may not be happy in their failure. If their behavior is in some or in all respects quite unacceptable to the community, they are considered in the eyes of the law as insane, i.e. legally not responsible. But not all of those whose mental health is not good come under this legal classification. Behavior may be quite harmless and inoffensive, although not adapted to the conditions of living, and therefore not normal.

The matter of getting along in the environment and among the people with whom one is thrown is one of the important tests of mental health. The mind is for the purpose of producing adapted behavior. When it is doing that comfortably and well, and the individual is able to get along smoothly with all sorts of people, to square himself with his own standards, and to meet with equanimity and a satisfactory response all sorts of situations, and be happy in so doing, he may be considered as having mental health.

There is no sharp dividing line between those who are frankly mentally ill and those who are on the whole normal. Formerly this was thought to be the case—just as there was thought to be a sharp dividing line between those who were physically ill and those who were well. As has been shown, not all the so-called well are entirely well. A state that is apparently health may be capable of improvement, and this applies to mental as well as to physical health. A large number of individuals are, in respect to mental health, not up to their own maximum. Most individuals have at some point an inability to reason clearly, although it does not unfit them to get along with others and to look out for their affairs. Not all of these show recognizable signs of mental ill health. They would not even, perhaps, be classed as "odd" or "peculiar" or "eccentric" or even as "temperamental." They may have only a personal awareness of such emotions as anxiety, depression, worry, fear, or of some unhappy or uncomfortable state of mind; or they may possess characteristics that crop out in certain situations and cause them trouble. They may, for example, have an irascible temper, or be extravagant with money, or greedy or lazy or "strung up," or

lacking in the power to decide things promptly, or failing in courage to be frank and truthful. All of these personality traits, and many others, represent to some degree the activation by unsuitable motives, the inability to react favorably to actual conditions and a resulting lack of harmony and satisfaction in life. To some degree they all represent a lack of mental health.

Sometimes assistance is needed in coping with one's bad mental habits, just as is the case with respect to bad physical habits. The general rules of mental hygiene do not always seem applicable. In such a case a mental hygienist (a physician who specializes in this branch of medicine, usually a psychiatrist) should be consulted. This should be done, not in the fear that mental disease is present or approaching, but in the expectation of learning how to reach a better plane in the complicated task of living.

Many of those who would be called neurotic (i.e. having mild mental malfunction) take pride in their condition. Particularly is this true if they believe their traits are a mark of sensitiveness and temperament, and of a delicately constituted individual as opposed to a "clod." Not recognizing their traits as signs of faulty mental function, they do not try to remedy them, which is unfortunate for those with whom they have to live. They themselves often get a great deal of a sort of satisfaction from their very defects, and seem to be only vaguely, if at all, aware of their failures.

Athough it is not possible to discuss the hygiene of the psychic life at all fully in the few pages that may be devoted to it in this volume, it may be briefly summed up by stating that the cardinal principle of mental hygiene is that of adaptation to living on the basis of recognizing and dealing acceptably with reality. Since it is usually unconscious motives and their accompanying emotional states that interfere with the facing of reality, some of these motives that so frequently cause conflict may be mentioned, and some of the mechanisms the mind may use to solve the conflict by evading reality.

The instinct of self-preservation has been mentioned as perhaps the chief of all the instincts. It includes the impulse not only to preserve the physical self, to keep one's self safe

and comfortable, but also to preserve what may be called the individuality. Involved in the latter aim is the very keen wish to consider one's self, and to be considered by others, as a person worthy of respect. Both of the kinds of motives are very prominent in all individuals. On the other hand, in all individuals there are other motives, that impel them toward situations that might be dangerous or uncomfortable or humiliating. Side by side in each one, there is the wish to avoid feeling unsafe and inferior, and the wish to strike out where danger but also ultimate glory and satisfaction may lie. Reality often drags one away from safety and protection, and often presents one to his own view as a less noble and able creature than he would like to be. In view of the wish to accomplish, it is inevitable that when reality is frankly faced, there should be some feeling of inferiority in its presence. No one can honestly feel entirely able to cope with all situations. In view of the wish to feel superior, it is, moreover, inevitable that the feeling of inferiority in the presence of reality should be an uncomfortable one. It is to get rid of feelings of inferiority, aroused by the confronting of reality, that many of the common faulty mental mechanisms arise. Many of the others arise from the desire to avoid feeling unsafe, as reality may necessarily cause one to feel.

A moderate sense of inadequacy is as normal as a wish to think well of one's self. Both normally keep an individual striving for higher levels. Either of these feelings may, however, become exaggerated. An undue feeling of inferiority and an undue wish for the feeling of superiority may lead an individual to conduct his life in such a way as to gain a fictitious satisfaction rather than a genuine one. There are countless false ways in which an individual may do away with the impression that he is not what he would like to be. There is only one real way that is permanently satisfactory from all points of view—that of being, or at least trying to be, an individual worthy of his own self-respect and the respect of his fellows.

When following the devious mental paths that lead to the banishing of inferiority feelings an individual may be quite unaware of the reason for what he is doing. In fact he may

be unaware of feeling inferior, having excluded the recognition of it even from himself. His behavior constitutes an unconscious compensation.

One of the most common compensatory mechanisms is the unconscious effort to persuade one's self that one is not inferior but superior, by acting as if the latter were the case. This is one of the most important mental mechanisms. It is even sometimes advocated by those who advertise in magazines that they can teach young men how to get ahead. Possibly to a very moderate degree it is useful; but it is generally dangerous to the mental health to act on any basis except the truth. Whatever superiority exists may be and indeed should be admitted to one's self. To assume a superiority that does not exist, even for the purpose of reassurance in making further efforts toward success, is likely to lead soon to satisfaction in the feeling itself, without achievement behind it to justify it.

The manner of the individual who thus compensates for feelings of inferiority is often an indication of the mental mechanism he is using. No one appears half so conceited as the individual who is unconsciously trying to fool himself about his own worth. It is very important to him to be always thought in the right. He is likely to be boastful, supercilious, and rude. Everybody should, he thinks, bow down to him. He is often harsh and cruel to others in order to impress them with his power. He seeks situations in which he has control over others, and then uses his opportunities to domineer over those in his power and to give himself a sense of importance. He can often be friends only with those whom he is able to fool, as he does himself, into thinking that he is truly superior. In the extreme this mechanism leads to delusions of grandeur, a common symptom in the mentally ill. In minor degrees it produces individuals to whom the first consideration is always the effect of any circumstance or any person on his ego feelings. Those who are browbeaten in childhood may develop this trait, or those whom some particular circumstance has caused to feel unconsciously inferior.

Humiliating conditions early in life may not lead to this sort of compensation, however, but may produce a conscious,

although unreasoning, feeling of inferiority. In such a case the manner may be that of shyness and lack of ease in the presence of others. Whether it produces compensatory self-aggrandisement or merely gives diffidence, the underlying feeling may be quite a false one. The individual in either case may be not actually inferior. It is just a question of how he consciously or unconsciously feels. But in either case the remedy is the same—obtaining some adequate ground for conscious self-approval, and guarding against the use of the mechanism mentioned.

One of the unfortunate results of an underlying unconscious feeling of inferiority is an overweaning ambition, that leads one to seek to do more than he can reasonably expect to do. The big achievement would, of course, be very acceptable to the inferior-feeling individual. Very often the great, distant goal is allowed to consume all his mental energy, while the smaller, nearby, really achievable goals are neglected. This gives him a still further feeling of inferiority, when he finds himself surrounded by tasks undone and the great aim no nearer to fulfillment. While holding the distant aim in view, mental hygiene requires attention to present acts. Sometimes the big aim should be frankly given up, for the time being at least. Giving up is not always a negative thing, but often a positive achievement of great psychological value. It may take more courage and clearness of thought than one possesses, to admit any disability. Yet at times the whole future of the mental health may demand it. In such circumstances, giving up is not cowardice and retreat, but bravery and a step forward.

Sometimes the reality that must be faced is that one is a better person than one wishes to believe—capable of more than is being done. If this were recognized, one could hardly fail to be impelled by the principle of "noblesse oblige." By ignoring one's abilities, or denying them, one permits one's self an easy life without effort. Students who pass intelligence tests high, and yet get poor examination marks, often are dodging the reality of their own ability, and following the instinctive lead toward pleasant paths. The safety motive may, however, keep them within the bounds of passing marks.

Happiness demands the choosing of an appropriate rôle, and the acting of the part as well as possible.

The motive of self-aggrandisement often affects one's attitude toward others. It may take the form of the belittling of others, in order to produce a sense of a corresponding rise in one's own status. This is often witnessed as the unpopularity of a very attractive girl among those of ordinary charms. It leads the latter frequently to tear to shreds the reputation of the other, indirectly establishing their own superiority. In business it leads to the successful man often being called crooked by his less successful competitors.

One's attitude toward others may involve projecting one's faults to them. A bad trait not admitted, but existing, in one's self is often particularly objected to in others. It is easier to dislike in others such a trait as greed, for example, than to face the fact that one has the trait himself. We dislike most of all those who represent ourselves at our worst. If we admitted the trait in ourselves we should have to do something about it. The ego is satisfied when we merely recognize that the fault is a fault. It stamps us in our own minds as discerning and having high standards, even though we cannot discern our own fault, and do not reach the high standard we approve.

The dishonest person is prone to find dishonesty in all those about him. He himself is deserving of suspicion, and he becomes suspicious of all others. He says, "You can't trust anybody." What he often means is that nobody can trust him.

The inferior-feeling individual is likely to use the mechanism of projection in another way. In order to free himself of self-reproach or blame he may heap the blame on somebody else. In common parlance this is known as "passing the buck." One establishes what is called an "alibi" for one's self. Failing at a given task, for example, would injure one's self-esteem if it were admitted. It is more comfortable to think that someone else is to blame. If it involves flunking a course, the individual who will not face the facts unconsciously persuades himself that the instructor was incompetent or unfair. Anything will satisfy such an individual better than admitting that his remarkable self was at fault.

Even inanimate objects may receive the brunt of one's self-disapproval. The one who has played a poor set of tennis may throw away his racket in disgust, not at it or at others, as he thinks, but at himself. The individual who has behaved childishly or otherwise ineffectively in an interview bangs the door as he goes out, unconsciously exhibiting the disgust with himself that he will not admit. If he faced his own shortcomings the door would not have to stand in his place to receive the signs of emphatic disapproval. Such acts symbolize what one would in principle do to one's self, although they are commonly supposed to symbolize what one would do to the other individual in the case.

Situations, too, may be blamed for one's failure. In college, the curriculum may be attacked as too heavy by a student who wishes to disguise from himself his own academic inadequacy. To noise and confusion in the house may be attributed the inability to settle down to study.

If the underlying feeling of inadequacy is very strong, and the environment and the persons in it, rather than one's own shortcomings, are supposed to be the cause of the inadequacy, the individual may go a step farther. From merely thinking others are in the way of his progress, it is but a step to imagining that they are deliberately in the way, and making active efforts against him. In the extreme this is called paranoia, a variety of mental disease. Minor degrees of the use of this mechanism are frequently seen in individuals who believe others "have it in for them."

Sometimes an individual may stop short of feeling that he is being persecuted, but may cherish a feeling of being scorned and blamed by everybody. It is more bearable to him to feel that others are blaming him than to blame himself, for in the former case he may justify himself by feeling that the blame is undeserved. The individual who feels that he is disliked and disapproved of may save his self-respect by adopting the attitude of injured innocence.

The individual with inferiority feelings often consoles himself by thinking of himself as "different." He enjoys feeling that he is misunderstood. He may be afraid to conform to usual standards in the fear that somebody will take

him to be an ordinary person. He scorns the "hoi polloi"; is contrary in his opinions; iconoclastic of current practices and standards; calls himself a non-conformist; and often cultivates oddness in dress and manners. Perhaps at the same time he has some genuine claims to distinction; but he may be one of the very many who are able to satisfy themselves by being merely "odd."

It will be noted that all of the mental mechanisms that have been mentioned are for the purpose of creating in an individual an impression that he is superior, an impression which he feels that he must have at all costs. They involve primarily a great need for self-approval, and consequent deliberate but unconscious efforts to protect one's self against that which would injure one's self-esteem. Yet with all these mechanisms of self-deceit there usually remains a sense of uneasiness that is an indication of their futility.

It is natural to wish to stand well with one's self, but it should not be so intolerable to admit lack of perfection. As long as an individual is bound to feel always thoroughly satisfied with himself, he will be likely to continue the use of these mechanisms to some degree, and to that degree to affect his mental health, his happiness and his adaptation to life. It is desirable not to require too great a feeling of self-satisfaction, and particularly is it desirable not to be misled into obtaining such a feeling by false means.

While holding to a high standard, one should recognize both faults and virtues. A recognition of one's own ability gives the reassurance that makes effort possible, and at the same time gives solace in view of the inevitable recognition of faults. No one is all good or all bad. No one should constantly feel either self-approval or self-condemnation—for neither will be in accord with the facts.

That there may be some sure ground for self-approval, the ego motives should be used to activate some sort of real achievement. The first step in overcoming inferiority feelings is to hold one's self to the performance of some one thing, even a little thing, to the best of one's ability. If the establishing of legitimate grounds for self-respect is the result, inferiority feelings prove to be of value. If short cuts

must be taken to get rid of them, they become the source of mental ill health. Mental health involves looking at things as they really are, accomplishing something worthy of one's admiration, and then stopping only a very short time to admire it before attempting something else.

Instead of, or in addition to, feelings of inferiority, there may be unduly intense feelings of self-blame. It is natural to blame one's self at times, but it is unnatural to blame one's self constantly. If such a prevailing mood arises, still other mechanisms may be utilized to give in its place a feeling of virtue.

A feeling of extreme guilt, often entirely or largely unconscious, determines a number of different types of behavior. Just as inferiority feelings are compensated by many sorts of behavior designed to assure the individual of his superiority, so are feelings of guilt compensated by many sorts of behavior designed to convince an individual of his virtue.

One of the commonest of these mechanisms involves the principle of atonement. The atonement mechanism that from the social point of view is the least successful is that which causes an individual to glory in his feeling of miserable unworthiness. Such an individual is depressed and inert, and cannot let himself be happy. His motto is "Life is real, life is earnest." But his goal is reached when he has fully convinced himself that he feels sufficient self blame and has created sufficient gloom about himself and others. Any joy in himself or others seems to him sinful; and yet he seems to be perversely happy in his unhappiness.

Hardly more socially acceptable is the individual who unconsciously atones for his feeling of guilt by a most meticulous search for duty. Every act of the day is turned into a moral issue. The great question on every matter is "What is right?" If the matter cannot be decided on such grounds, because neither course is more right than the other, he will suspend a decision until such time as he can summon the voice of conscience. But so apt has he become in distinguishing this voice, that he usually has not long to listen. Not only must conscience direct every indifferent act of his own life, but also of the lives of those about him—and it must usually be his conscience rather than their own that must be followed. If

others do not follow the dictates of his conscience it relieves his own sense of guilt to consider them also guilty. This obtaining of self-satisfaction by persuading one's self that others are equally at fault might well be called the "tu quoque" mechanism.

A far superior type of atonement-compensation is that which leads to lives of service to mankind. It may even lead to a willingness to undergo martyrdom for a great cause. On the other hand, there are very many individuals whose lives have been rendered both ineffective and unhappy by the necessity they feel for finding opportunities for great service or for martyrdom in everyday life. It seems less heroic merely to meet daily situations as they arise in a straightforward manner; but it must be recognized that it is actually often more heroic. It would more often appear so, were it not for an oppressive sense of guilt that drives so many individuals to seek a great and conspicuous atonement.

It should be understood, with respect to marked feelings both of inferiority and of guilt that there may be, in fact is likely to be, little foundation for them in fact. The most compelling necessity for atonement may arise from an entirely fictitious sense of guilt, aroused perhaps in the first place by self-blame for a minor error that was conceived of as a heinous offense.

While the individual is carrying on his life according to the various mechanisms mentioned, his conscious mind is being used to justify what he does on the grounds of reason, by a process known as rationalization.

The conscious mind may be used in two ways. The first is known as reasoning; the second is known as rationalizing. The two processes are superficially similar, in that each involves the presentation of reasons for behavior. Reasoning takes place as a preliminary to consciously determined action. It presents its arguments for a contemplated action before the action has been decided upon or accomplished. Rationalizing, however, takes place after an unconsciously determined action has been decided upon, or even after it has been performed. It is for the purpose of supporting the individual in the theory that he always behaves according to reason, or rationally.

One of man's favorite conceits is that all his opinions and decisions are made by the use of the intellect. One of the forms of self-approval that is most important to man is the feeling that he is a reasoning, thinking being. Very few individuals are willing to admit even to themselves that they are guided by anything but logic. An act already done or planned on the basis of an overpowering feeling, will therefore be subsequently accounted for as the product of brain activity alone.

Rationalizing is for the purpose chiefly of justifying one's self in one's own mind, and only secondarily to fool others. The man who steals, for example, must feel that he was right in doing so, or his punishment at the hands of his own personality would be more severe than his punishment by the courts. He therefore clears himself in his own mind by some such rationalized belief as that the world owes him a living, or that rich men are fair prey, or that the one from whom he steals has no more right than he has to the thing stolen. Having done what he wished to do, he is able to make himself feel that he behaved both rationally and justly.

Arguments may be produced to satisfy one's self of the moral and intellectual rightness of any sort of action that instinct indicates, or that are performed on the basis of the compensatory mechanisms, when the recognition of the real cause of the behavior would be unacceptable to the whole personality. The individual, for example, who needs to feel his power in relation to others, and becomes a harsh disciplinarian of children, convinces himself that the good of the children demands such measures.

The mechanism of rationalization is also much used in defense of opinions as well as of character traits and behavior. Even opinions on theoretical matters are held very largely for emotional reasons. This is true in the case of most of the opinions of most individuals. Such opinions may be casually held and expressed, after not even the slightest consideration of the facts involved. The reason that they come so readily is not usually that the evidence on which sound opinion might be based is already in the individual's possession, but that he does not need or want evidence. All that he needs in order to

"make up his mind" is to discover how he feels on the matter. Previous confronting of similar occasions for expression of opinion may have shown him that he feels on certain matters very strongly, and is beyond convincing to the contrary. He may, however, be willing to go through the motions of listening to new evidence, considering himself still open-minded. In either case, if the facts do not influence him and he is influenced only by his feelings, he is said to be prejudiced.

Prejudice has its root in the emotional needs of individuals. It may be far more important to the prejudiced to hold fast, for example, to his childhood opinions, hallowed by associations, than to see reality clearly. In a given instance it may be far more important to him to hold an opinion that leads to his own comfort and self-esteem, than to run the risk of acquiring knowledge that would be upsetting or uncomfortable or demand a new sort of action on his part.

Since most individuals would lose their self-respect if they thought they were prejudiced or at any point failing to reason, they therefore, while holding firmly to their prejudices, build up elaborate rationalizations for what they "think." Under such circumstances considerable assistance in the defense of one's own emotionally determined opinions may be secured if those who hold opposite opinions may be condemned as irrational. This the prejudiced individual usually does. The strong partisan of any prejudice is as active in attacking the intelligence and even the good faith of his opponents as in championing his own ideas. In extreme degrees prejudice leads to dangerous fanaticism.

It has already been mentioned that that which arises on an instinctive basis is most likely to be surrounded by an aura of emotion. Any very ardently held opinions are likely to be based on instincts rather than on reason. Feelings are as legitimate in their way as reason, providing the two are not mistaken for each other. An individual should survey his warmly held opinions to see whether they represent blind emotion, or emotion justified by facts. An illustration of blind emotion leading to prejudice is that of the anti-vaccinationist. For many different reasons, an individual may feel an objection to vaccination against smallpox. The scientist,

however, who knows the facts about smallpox and its preventability by vaccination, feels even more warmly on the matter. His emotion follows his knowledge of the way in which vaccination affects human welfare; whereas the emotion of the anti-vaccinationist precedes and is uninfluenced by the facts. Science is said to be "cold" because it is unemotional. Yet when it touches that which is vital to man, and deals with matters of individual and race preservation, it too may become kindled with emotion. It is important to distinguish, so far as possible, between those emotions that are valid, and those that are not; between those opinions that are soundly reached and those that constitute prejudice.

On many matters opinions are held by those who are not entitled to them. The only ground for an opinion on a given matter is sufficient knowledge of that matter. Yet the average individual holds, or can produce, emotionally determined opinions on almost any matter that is presented to him. He "knows" why the income tax is a failure, and why the League of Nations is a success. In regard to his own life, he "knows" what he ought to eat and what sort of exercise is best for him. Not being an expert on any of these matters he does not really know; he merely feels that certain things are or should be thus and so. Seneca said, "Many men had been without question wise, had they not had an opinion that they had attained to perfection of knowledge already, even before they had gone half way."

Although rationalization is chiefly for the purpose of fooling one's self, it may easily be used also for the purpose of fooling others. It is but a step from efforts at self-justification to justification in the eyes of others. Although one's own self-esteem is of the utmost importance, it is often greatly dependent on the esteem of one's fellows. An individual, therefore, may seek to bolster up his approval of himself by seeking social approval. From unconsciously deceiving himself he may fall into the habit of consciously or unconsciously attempting to deceive others. This he may do either by lack of directness or frankness, or by actual misrepresentation or lying. The wish to appear to others in a more favorable light than is warranted is perhaps the commonest cause of lying. Since

words may be so easily used to convey an impression that deeds do not convey, it is natural that the individual who feels inferior should seek this easy path to approval. This constitutes lying for the purpose of self-aggrandisement. Lying also results from fear. It is the resort of the craven coward who dares not face the consequences of stating things as they are. This is lying for self-protection. Another form of lying is for the purpose of injuring others; but it does not necessarily involve pure malice. It may be chiefly in order to make the contrast greater between the individual about whom the falsehood is told and the teller of it—the latter hoping to rise in popular esteem as the other falls. Finally, lying may be due to inability of an individual to distinguish between what is true and what is false. Such blindness is quite general in children who have not developed the ability to check their imagination with reality. If it persists into adult years it does so because the individual has not acquired this ability as adults should.

A common mechanism of defense is represented in such individuals as do not distinguish between the true and the false—that of fantasy. Individuals who resort to it do so in varying degree, and to that degree are in the world but not of it. If in childhood the imaginary world seems very real, it may be quite difficult to cease to "make believe," or even to recognize when one is making believe; and the childhood habit may continue. Even in adult years, however, the habit may be resumed after it has been stopped when real situations become too unpleasant. In self-defense the individual may withdraw into a life of fantasy or imagination, refusing to think about the actual, disagreeable facts, or even to recognize their existence. Such individuals to some degree cease to live in the world of here and now. They take up their abode, instead, in castles in the air, peopled with individuals not at all like the real ones they know, they themselves not at all resembling their real selves. Life is luxurious, their friends are all kind and considerate and appreciative, they themselves are gifted and noble and successful—all their wishes come true. Time may change from the present to the past or to the future. Sometimes the scene is laid amid the familiar; sometimes it is wholly

imaginary. Such individuals may be entirely happy living in their dreams, no matter how at variance they are with the facts. "I dreamt that I dwelt in marble halls" is to them more satisfactory than troublesome contact with what seem to them tawdry realities.

When carried to the extreme this mechanism produces individuals who entirely shut out the real world, and become thoroughly deluded. In lesser degrees it produces individuals who are known as "shut-in" personalities—whose joys come chiefly from within their own minds, and to whom the world of events is less real than the world of their own imagining. Sometimes they are described as "day-dreamers." If they express their thoughts, so that others know what they are about, it usually indicates a less complete retreat from reality than is the case when they cherish them entirely within their hearts. Such individuals as give vent to their dreaming are said to have vivid imaginations. It is from them that creative work is usually expected. Sometimes such an individual really does create—if he succeeds in harnessing his imagination. Imagination is the fountain of art and even of scientific discovery, if the imagination is kept in contact with the real world. It is a deadening substitute for life if it feeds entirely on itself.

Day-dreaming is quite permissible to a very moderate degree. It is not necessary to refuse to think of what might be. On the whole, however, only that amount of day-dreaming should be permitted as will start action and give it color. One should dream of the possible and then make some moves toward its realization.

Buying books they never read, composing letters they never write, creating situations they never even try to materialize—these are the ways of the dreamer. The satisfaction that should come only when a thing is done, they are able to get at the stage of planning—their obliging imaginations leading them to see the thing as already done. Yet the whole personality seldom approves of the lack of results, and in time the day dreamer is likely to be quite dissatisfied with himself. If he is sufficiently and normally dissatisfied he may then come back to earth and face the situations, some of them at least, that he has been avoiding.

Fancy often plays havoc with adaptation to life, by interesting individuals in dreaming not of what might be, but of what they recognize cannot be. This sometimes takes the form of vicarious living in the lives of others—such as the heroes and heroines of novels, plays and moving pictures. For some this becomes an entirely satisfactory substitute for personal experience, and constitutes the main way of getting joy from life. Rather than live their own lives, they prefer to identify themselves with those who do what they themselves would like to do if they had courage enough, or if they were powerful enough, or charming enough, or if their conscience would consent—for it may be the villain rather than the hero with whom identification takes place. It is not only the flighty who glory in the adventures of highwaymen and "vamps."

Identification with heroes is not always harmful by any means. It only becomes so when it leads an individual to cease to be much interested in his real life. In extreme cases the mechanism of identification may cause an individual to believe incontrovertibly that he is, for example, Caesar or Napoleon or Rockefeller. In minor degrees, it leads to sharing too fully in the triumphs of others, and too easy satisfaction with what one feels capable of accomplishing but never even tries to accomplish.

A common type of flight from reality is represented by taking refuge in physical ills. If one is ill he may feel justified in his own mind for many acts unperformed. Even genuine symptoms of illness, such as headache and indigestion, may come on at the behest of the unconscious part of the mind, to make impossible that which one finds disagreeable. Illnesses that come on when there is an unpleasant task to perform afford an excellent means of unconscious self-protection. In the army many symptoms of illness were found to be the result of the inability to face the distressing reality. If a man were paralyzed, for example, he could not remain at the front. Unwittingly, therefore, he became paralyzed, or blind, or afflicted with some other ailment that his unconscious mind ingeniously devised to take him out of an abhorrent situation. In all sorts of individuals this tendency is seen to some degree. A very real feeling of unfitness may often be a flight from the

reality of an examination or a term paper, for example. Such illness is called hysteria.

Many annoying physical ailments that are continuous represent a continued failure to adapt to one's circumstances. The misfit in any occupation is likely to have poor health. This shows in a general feeling of weakness and lassitude, and in numerous other ways. Those who have this tendency to a pronounced degree are called neurasthenic.

There are those who do not show signs of retreat from reality in physical symptoms but in mental symptoms of various kinds—such as fears, anxieties and obsessions. Those who have such tendencies are called psychasthenic.

A tendency to worry, either about everything or about some special sort of situation, is particularly characteristic of the psychasthenic. Chronic worrying always results from some faulty adaptation to living, such as may accompany the use of the various mechanisms for escaping from reality. Anyone who can think, however, occasionally feels fear or anxiety. Both emotions are like pain in that they act as warnings to prevent persons from getting into harm, and to cause them to make wise provision for present and future situations. The normal individual confronts reality anyhow, fearful as it may be. He does not let his need for safety govern him to the exclusion of all other motives. Quite frequently a particularly strong tendency to fear or anxiety cannot be uprooted by the individual unaided, because he cannot find any reason for it. In such cases the assistance of a mental hygienist is needed.

The status of the emotions has been seen to be that of accentuating the various motives through bringing to the attention the desirability or undesirability of acting on them. It is because one feels agreeable and satisfying emotions when certain motives are acted upon, or at least expects thereby to experience such emotions, that those motives prevail. It is only by means of the emotions that surround them that the motives become activating forces. They are therefore of the greatest value if they are used in adapted ways. On the other hand there is much to be said against permitting the emotions to run riot in influencing life. The motives they

accompany must be harmonized with life, and the emotions themselves utilized to gain power in the directions determined by the whole personality. It is seldom permissible to act solely because one feels.

Still less is it permissible to react to a situation by exhibiting the emotion one feels toward it, without making a parallel active response in deeds. One of the very common responses to difficult situations involves "emoting" about it, and doing nothing else. We have coined this verb "to emote," meaning to show emotion in unsuitable ways and degrees. There is, of course, no absolute standard for the exhibition of emotion. Custom varies among different races, at different ages, and even between the two sexes. What would be ordinary behavior in some races, would be considered outrageous in others. That which is hardly heeded in children, perhaps mistakenly, would be a mark of a disordered mental state in an adult. Girls and women may, without arousing comment, show some emotions that normally men do not. There are also different standards according to situations. Shouting with enthusiasm at a football game is quite usual, whereas shouting in a classroom would be unexpected, to say the least.

Whether the exhibition of emotion is in accord with custom or not, it is not appropriate unless it meets the needs of a situation, and, moreover, does so in a way that is finally most effective. A good deal of emoting occurs because the individual believes that the emotion actually does constitute the best solution of a problem. For example, temper tantrums, that are fairly common both in children and adults, may be used consciously as a means of gaining certain ends. An individual who flies into a rage knows that those with whom he is dealing are likely to quail before an outburst of temper, and be only too glad to secure peace at any price. Very commonly temper tantrums are an unconscious mechanism, used for the same purpose. In adults they are usually rationalized as righteous indignation against an intolerable situation. Of course the logical individual feeling righteous indignation would attack the situation by more appropriate action.

"Emoting" is a common practice among young adults in particular, who often consider that a situation has been met

when they have expressed their feelings about it. A strong feeling should be merely the beginning of action. The aim should be to turn all one's feelings into channels of suitable activity. It is perhaps more harmful to get "thrills," even of inspiration, and to fail to follow them by efforts at achievement, than never to be thrilled at all.

Those who have and express many violent likes and dislikes should question both the rationality of them, and their effectiveness. Those who "can't bear" or "simply adore" this and that, will often find themselves in situations where they are at the mercy of their strong preferences and aversions, and hampered in rational action accordingly. It is better to increase, if possible, the range of one's sympathies and pleasures and to reduce the intensity of one's hates. It is a mark of mental health to like many people of many kinds and to have sympathy at least for all, and to find one's self at home in groups of all kinds. The ability to get on with a roommate may be a test of one's mental health.

Adaptation to real situations is sometimes not at all easy. It is particularly hard for some individuals when they first leave home. The appeal of safety and protection and family affection, and the desire for the unqualified acceptance as persons worth consideration, draws them strongly back to the family and the home ties. Valuable as family life is, in the support it gives its members, it must usually be dispensed with to some extent in adults. The adult must learn to make new associations and new friendships and acquire new kinds of approval. It is natural to be a little homesick, but such a degree of it as to cause failure to adapt to such a situation as college, for example, represents too strong a claim of the instinctive and lack of its proper direction. In freeing one's self from bondage to the familiar, an individual is not doing violence to his affections, but developing them to an adult, adapted level that is more suitable for him and for his family as well.

Adaptation to reality is also very hard for those in whom the herd instinct is particularly prominent. The desire to be in accord with one's fellows and to have social esteem leads often to the sacrifice of one's own personal wishes and to one's

reasoning power. It leads to the observance of conventions because they are conventions and not because there is any sound reason for them. Such an individual, for example, wears the same kind and amount of clothing that others do, regardless of economic or health considerations. He is more embarrassed at small mistakes in etiquette than at moral faults. He thinks what the group thinks, having listened eagerly to the rumors that are the vehicle by which the herd instinct gets itself into operation. What "they say" is far more important to him than what he himself thinks, in fact he does not think except as the herd thinks.

Humanity often thinks and feels in the mass. It is thus that wars and lynchings are possible on the one hand; and on the other hand, that the Declaration of Independence was possible. The group is sometimes right and sometimes wrong, just as are individuals. Its opinion is as likely as that of individuals to be emotionally determined.

Adaptation to reality does not invariably imply conformity to the group wish as it is currently exhibited. It does, however, imply the adaptation to the real group wishes. which are, under all, those for the advancement of the social welfare. There is a vast difference between the blind "follower" of the herd's often superficial and temporary wishes and the individual who recognizes a claim on him by society that is as important as his ego's claim.

Many of those who deal with psychological matters emphasize the importance of suggestion as a means of cultivating a satisfactory state of mind. There is undoubtedly a marked tendency to grow to believe that which is often asserted. For this reason great care should be taken in regard to the use of suggestion. That which is suggested may always be classified as either true or false. If it is true, suggesting it amounts to facing reality. If it is false, suggesting it amounts to evading reality. A warning should be given against the making of untrue suggestions, even of those things that would be desirable if true. Untrue suggestions of health and success, for example, might prevent real efforts toward the attainment of health and success. Untrue suggestions of that which is undesirable may be even more disastrous. By reiterating

sufficiently often, "I am a failure," one may readily make himself believe that he is one, and actually may become one. Perhaps even more important is it to avoid implanting adverse suggestions regarding themselves in the minds of others.

In the effort to solve conflicts between conflicting motives the mechanism of substitution is very often used. Some other goal is substituted for the one desired. If one is unable to do the thing he desires he may do something else, and gain the same satisfaction thereby. The thing substituted may act as a symbol of what is really desired. The symbol, however, may be much easier to reach than that which it symbolizes. In the satisfaction of instinctive wishes it is sometimes more appropriate to permit symbols to engage one's interests. It is, however, often injurious to permit a symbol entirely to take the place of reality, when by an effort the reality itself could be reached. Those whose emotions respond readily to the symbol of the flag or the cross may have little practical patriotism or religion. In the same way, those who are eager for marks—presumably only the symbol for educational achievement—may entirely lose sight of what the marks represent.

The mechanism of substitution may lead either to less favorable or to more favorable adaptations. The individual who feels inadequate and discontented in one field of work may substitute a still better field in which to demonstrate to himself his adequacy and to find happiness. It is often thought that the "grind" is substituting intellectual achievement for the social success he cannot win. Probably in college the opposite is as often the case—the student substituting efforts to shine socially for what he feels would be futile efforts to win distinction academically.

There are innumerable ways of reacting to any situation, some of which actually meet the needs of the situation and make others like it easier to meet, and some of which make both that situation and similar ones harder to meet. Whatever one's instinctive unconscious wish, if it may not be realized as such, it may be given another means of gratification. There is practically always some substitute for the primary object of one's desires. When the substitution brings about behavior that is at the time and in the circumstances more

suitable, and more in accord with the whole personality, it is called sublimation. The mechanism will be referred to in reference to dealing with the sex instinct. It is quite as important in dealing with the ego instinct. It has been seen that the ego instinct, if left alone, may draw an individual into habits of which he is unaware, and which he would not adopt if he knew what he was doing. This is not always the result, however.

Even if left alone, the desirable mechanism of sublimation may take place unconsciously. Many professions and careers are chosen on such an unconscious basis. That aspect of instinct that is represented by curiosity, for example, may be sublimated quite unconsciously so as to produce the research worker. Even the crude instinct for self-aggrandisement may be sublimated and become the foundation of leadership. It has been shown how some of the instinctive mechanisms of self-defense, such as that against a feeling of guilt, may lead to lives of self-sacrificing devotion to a great cause.

Since instinct in one way or another will inevitably be involved in behavior, and since sublimation of instinct does not by any means always occur by itself, it is always desirable on the one hand to make certain, so far as possible, of the nature of one's tendencies; and on the other hand, to gain as much knowledge as possible of the circumstances in which one's life is set, so that the direction of one's impulses be appropriate.

When properly sublimated—turned into channels that, when facing facts, the whole personality approves—the ego feelings become the root of valuable self-reliance, happiness and adapted, successful behavior. When thus sublimated they take cognizance not merely of the immediate claims of the ego, but also of the claims of society as a whole, which may be considered as the extension of the ego. Social claims do not run counter to, but parallel to individual claims. Self-realization in the larger sense is very far from the currently much commented on, and much criticized, entirely self-considering type of "self-expression."

Until recently it was not known that there were scientific procedures to keep the mind in health. But many minds

remained well in spite of lack of knowledge, just as did bodies before the hygiene of the physical life reached its present status. In each case it was accomplished by the means science now endorses. The advantage of the present knowledge over the previous haphazard methods is that now results may be counted on, instead of merely being hoped for. By the exercise of the traits of personality that need to be developed, one may count on results as surely as from the exercise of the muscles —for the personality is not fixed and static, but capable of change, even from day to day. Even a sense of humor may be trained—that most valuable trait that enables an individual to look at reality without being staggered by it, and to handle reality with the light, deft touch of the artist.

CHAPTER XLIII

THE HYGIENE OF THE REPRODUCTIVE SYSTEM

The organs of the reproductive system need very little care, their health being largely assured by the efforts made toward the health of the body generally; but there are several functions of this system that may be greatly influenced in their action by measures of physical and mental hygiene. One of these is the regulation of the reproductive instinct.

The sex organs do not attain their full size or take on their special function of producing ova and spermatozoa until the time of puberty. At that time they also begin to produce an internal secretion that makes more evident the secondary characteristics that distinguish one sex from the other.

In addition, as has been mentioned, the internal secretion of the sex glands is concerned with the existence of the creative impulse, or, more specifically, of the sex impulse. It is because of the effect of this internal secretion that individuals possess what is called the instinct for reproduction, or the sex instinct.

Man, like animals, has been shown to have certain preformed synaptic connections between neurones, that make possible direct responses, in unconsidered ways, to appropriate stimuli. There are many such pathways of instinctive response with which each individual is endowed at birth. One does not necessarily act upon them because they exist; but, because they do exist, the proper stimulus, when it arrives, is likely to produce in each person a response that is similar to that which any other person would make to the same stimulus. One of the earliest of such instinctive responses is that of the weeping and wailing of the infant—quite upon the basis of instinct—if the time for feeding arrives without the arrival of food. This behavior is said to be the exhibition of the nutritive instinct. It is a part of the general instinct of self-preservation.

As time goes on, other instinctive responses appear as their stimulus appears. Usually at about the time of puberty the sex instinct becomes capable of being stimulated toward reproduction. If the endocrine secretion of the ovary or the testes is absent or not secreted in sufficient amount, the stimulus of this instinct may be delayed until such time as these endocrine glands are acting more freely.

Because of the existence of the sex glands and their secretion, life as a whole acquires in adult years a more or less prominent sexual aspect. This is important, because it is the means by which individuals are impelled to carry on the reproduction of their kind. If the self-preservative instincts are fundamental for the preservation of the individual, the sex instincts may be said to be fundamental for the preservation of the race. For the individual they also have value, since many of the greatest satisfactions of life come about through the exercise of the sex functions—in love for an individual of the opposite sex and in the bearing and rearing of children.

It is believed by some that the sex instinct is the most important of all, and that the instinct for self-preservation is secondary to that which has to do with the preservation of the race. However it may be, most adults realize that life is rather generally colored by the emotions, the thoughts and the activities that proceed directly or indirectly from the sex instinct, and that many of the customs and institutions that society has established are for the purpose of controlling and regulating the responses of its members to this instinct.

The most notable fact about all of the instincts is that they possess a great deal of driving power. A man in whom the fighting instinct has been aroused may hardly be restrained from an exhibition of it. The man who is hungry will perhaps steal to satisfy the hunger instinct. A second important observation about the instincts is that they all produce profound emotional states. One has only to watch a baby crying for its food to realize that the baby is intensely unhappy. But after the food has been secured the emotional state quickly changes to one of the utmost peace and content.

The sex instinct is as powerful as the others in urging its demands, and it is as likely as the others to produce disagree-

able states of mind before its demands are satisfied, and agreeable states after they are satisfied.

The earliest motives for action, and even now the most fundamental, were those provided by the instincts. It is thought that primitive man had more powerful instincts than modern man; but part of the difference between primitive and civilized man, with respect to the prominence of instinct, may be that the latter has developed other sorts of motives for action, which motives tend to exert a dampening effect on the natural exhibition of instinct. With civilization, man has developed the ability to think. Consideration of the suitability of acting on an instinctive basis frequently shows man that such activity is not suitable. The man who is strongly impelled by hunger, and is moved to steal food, if he thinks about it at all, may realize that the demands of society and even his own higher ideals do not permit of taking that which belongs to others. Rather than steal food he may be willing to suffer a great deal.

Most of the conflict in life occurs because of the gaps existing between that which is strongly and instinctively indicated, and that which is as strongly but intellectually indicated. During the early years of adult life, when the force of instinct is very strong and the intelligence has not yet gained its full power, such conflicts are particularly likely to occur. They may occur in respect to the control of almost any instinct, but because of the force of the sex instinct they are particularly likely to be rather tumultuous conflicts when they involve sex.

It is early observed that the social ideals, and also often one's personal ideals, demand something different from that which the sex instinct demands. Society demands that there should be no expression of the sex instinct as such until marriage. This is because the sex instinct is primarily for the preservation of the race, which, society quite generally has concluded, is best served by the present form of family life.

It is quite early apparent, however, that although this instinct may have the ultimate purpose it has just been said to have—that of race preservation—it has more immediate purposes. The way in which its final goal is reached is by the

attraction of individuals of the opposite sex to each other. Quite without any conscious thought of reproduction, this sex attraction may become an important feature in life. While leading very directly to the relationships that make reproduction possible, it may draw no attention to its ultimate purpose. It is because man has an instinctive urge toward reproduction that he is also urged toward those acts that lead to it. Frequently it seems that the urge is toward those acts in themselves. They in themselves give pleasure and are at times overwhelmingly attractive, apparently in order that the reproduction of the race shall never fail of accomplishment. No other so successful means could have been devised to insure the continuation of the race than to make the two sexes so irresistible to each other.

But as has been mentioned, the intellect is a powerful force against the natural indulgence of all sorts of instinct, and is even capable of controlling this most powerful one of all. The conflict that arises when instinct and intelligence are opposed may be solved in three ways: either instinct wins, and the individual follows its behest; or the intellect wins, and the individual denies all the claims of instinct; or a compromise is reached. The latter is in many circumstances by far the better solution of the problem.

The first solution appears to be "the easiest way," but in its trail follows the inevitable result of reverting to a level no higher than that on which the animals act. Degradation and disease are common results; and these involve not only the individual himself but those who go with him to the lower level, and those, often blameless, who suffer by his behavior. The whole social structure is based on the effort through the ages to rise above the level of action on unmodified instinct; and the whole social structure is affected by each lapse from higher standards.

The total denial of instinct is perhaps almost as faulty a solution of the problem, because it involves the repression of that which is entirely natural and valuable if properly used. Under such circumstances the fact of sex, which is not faced but hidden, continues to exist. Beneath the surface of the conscious mind it causes unhappiness that cannot be accounted

for, and faulty adjustments to life that may render the individual unfit to take a normal part in the affairs of the world. The individual who utterly ignores and tries to deny the existence of sex is preparing for himself the sort of rewards that always follow the effort to dodge reality. Deceit, even self-deceit, is a mistake because it does not supply a firm foundation for behavior—in other words, because it does not work.

The third way of solving the conflict between instinct and intelligence consists, first, in accepting present social standards—that sex as such must not be acted on except in accordance with the customs of monogamy, that it is natural and desirable under such circumstances and undesirable in all others. The second step involves the devising of ways by which the sex impulses may be not repressed, but harnessed and controlled.

In many normal young people, the great force represented by the sex instinct does not cause any particular difficulty, because they learn quite naturally how to direct it and control it in ways that are approved by the intellect. This is more particularly true in the case of those who have learned to look at all sorts of problems squarely, not evading issues, or dodging realities. It is also true in the case of those who have learned to restrain other sorts of impulses, for the good of themselves or of those about them, and have not been accustomed to having all their desires of all sorts immediately gratified. This sort of training, even though begun late, gives much assistance in the training of the sex impulses.

Without being aware of it, many individuals utilize the mental mechanism known as sublimation, which consists of a re-direction of the force supplied by the instinct into channels that are in the circumstances more socially and personally acceptable. This process is somewhat different from that of substitution, which involves occupying one's self with other interests than those that instinct suggests, with the aim of excluding the latter interests. Society life serves as a substitute for many women, and business life for many men. Sublimation, however, is very much more satisfying than substitution, in that it utilizes in another direction the same creative urge that the instinct provides. It is thought that

the impulse to achievement of all sorts has its root in the internal secretion which is the immediate source of the sex instinct. Both psychologically and physiologically the creative impulse seems to be dependent on the internal secretion of the sex glands.

Sublimation involves the utilisation of the creative impulse, not its thwarting. In order to be a true and permanently satisfying sublimation, the work which is undertaken with this in view must be such as to involve the use of one's best efforts, and to represent almost as truly as physical reproduction the expression of one's self. The individual who is merely crowding out sex interests by other interests may find that these other superficial interests fail him at time of need; and that at most times they fail to give anything like the satisfaction they should. The work may be done conscientiously and well, or it may be merely drudgery. Even other pleasures may not be entirely satisfying.

On the other hand, the one who has established a satisfactory sublimation finds almost, if not quite, as much gratification in one form of self-expression as in the other. This is because each represents the force of an instinct and the satisfaction of acting upon it. It is not merely what is commonly known as "creative" work that may be utilized in sublimation. Any work that one may find at hand, if it is done with all the force of the whole personality back of it, is creative work, and offers a channel for what might otherwise be the dangerously pent up or perhaps inadequately pent up force of instinct.

Although substitution may serve for a time, sublimation offers the only satisfactory means of coping with the reproductive instinct under circumstances when the intellect directs that it should not be utilized in native ways. Sublimation often takes place automatically, the individual finding out for himself that merely keeping himself occupied is not enough, but that he must put all of himself into a task and utilize all his strength in making the task as representative of him as possible. It is frequently necessary, however, to give some thought to the establishment of an adequate sublimation and to its subsequent maintenance.

If the sex impulse is dealt with in suitable ways, it is not a disadvantage at any time in life. Nevertheless, it is desirable, in order that efforts at sublimation may be successful, that physical conditions and environmental situations should not be such as to lead to its undue stimulation. If too much stimulation occurs, it is to that degree difficult to maintain the chosen level of conduct. It is thought that considerable assistance in avoiding undue stimulation is secured through good general health. It seems to be true that those who are physically active have less difficulty in this respect, as in many other respects.

It is also generally thought that opportunities for the stimulation of the sex instinct should be somewhat limited. An entirely protected environment, one that provided no natural stimulation, would be detrimental to development. Moreover, such an environment could hardly be completely effective, since stimulation is known to originate from within, even if none is supplied from the environment. Generally speaking, it is desirable to avoid those circumstances that lead most particularly to stimulation. An individual may discover for himself the sort of situations he should avoid in order to minimize this effect.

The social conventions are customs that have grown up out of the experience of the race. They persist because they have been found useful in preventing situations which are likely to lead to difficulites. They were never at any time arbitrarily devised for the limitation of freedom—as many appear to believe. Young people of every generation fail to understand why those who are older insist upon the current conventions. It is because the experience of the latter leads them to suppose that danger exists, and that it may be avoided by behavior of the conventional sort. It may be that the supposed danger does not exist, and that, if it does, it may be as satisfactorily met in other ways. Before casting aside any convention, however, it should be subjected to scrutiny as to its utility for the average individual, rather than for any special individual. Those who are particularly well sublimated, or are not very easily aroused by sex, may not be able to understand the necessity for conventions in the case of those who are less fortunate.

There are two very strong arguments against "petting." The first is that it may lead to infection—a subject discussed elsewhere. The second is that presumably innocent petting approaches closely to a very narrow dividing line separating it from definite sex conduct. That the border is so near is usually not recognized, especially by girls, whose emotions are usually, with respect to sex, less easily aroused than are those of men. Quite without any knowledge of the nature of the possible excitation, an individual may suddenly be overcome by it. In girls there may be no sex impulses aroused by petting; but in men there is usually a definite response, which is perhaps with difficulty controlled. There is considerable strain on the nervous system involved in approaching sex relationships and then denying them. Both mental and physical health may thus be impaired.

Indulgence in alcohol has a quite definite effect both on the stimulation of sex and on the weakening of the powers of judgment and control. Behavior that would not be contemplated at all under ordinary circumstances is likely, after even a small amount of alcohol has been taken, to seem either harmless or perhaps inevitable. This is one of the strong arguments urged by the prohibitionists.

It has been presumed that a compromise with sex, and the postponement of its direct gratification until marriage, is the aim of most young women at least. Unfortunately there has existed in the past an erroneous idea that such self-restraint was neither necessary nor desirable for men. It was held that virility demanded exercise of the sex function from early youth onward. This is not the case. The physical and mental health of neither men nor women is at all adversely affected by self-restraint. On the other hand, the use of the sex impulse as such, when the personality approves, has no adverse effect on health, unless it be used to excess, or in circumstances that lead to infection. Those who consider all sex indulgence as shameful and injurious are as wrong as those who advocate its free indulgence. The question is one of suitability. If restraint is desirable, it is possible, and not injurious.

There are particular reasons why most women have been able to exert restraint. One reason is that it has been so vigor-

ously demanded of them by men, and by society as a whole. In almost no groups is a licentious woman respected. A second reason is that women themselves have wanted to avoid the physical consequences in pregnancy and the ensuing social dilemmas. The fear of social consequences has had little restraining effect on men; nor has the fear of disease, which they expect always to escape. Probably the bringing about of a better standard among men will result only when women are sufficiently well informed regarding the effects of promiscuity on themselves and their children to demand the same restraint on the part of men as men do of women. Many men, however, need no coercion by society to realize the advantages of confining sex relationships to the marital state.

The supposedly free-living individual is often bound by the necessities of a habit which may cause his whole life to get centered about sex, to the detriment of all his other interests. Self-indulgence in sex ways utilizes the creative impulse at its source, and tends to leave inactivated many of the other potential powers, that might have been activated by its sublimation. It is probable that many of those who have accomplished the most in the world have been those who have redirected their sex instinct for the most part into other channels. The individual who finds all the satisfaction that he needs of that instinct in sex acts, often does not make other causes for satisfaction in life.

The advantages of monogamy have been questioned by individuals who felt restricted by its bonds, but society has not seriously questioned its advantages as a means of promoting family welfare and social stability. The church believes that it is also a great force in the direction of personal character formation. The science of medicine generally agrees that it tends toward better physical and mental health than other kinds of mating would do. Early marriage has been advocated as a remedy for the conflicts that arise around sex. It should be noted that this would remedy the situation only in some cases, for not all individuals are in a financial position to marry early; and even for those who can marry early the problem of sex is not necessarily settled permanently. The individual who cannot solve his sex problems before marriage should not count on having them all solved by marriage.

It cannot be denied that large numbers of marriages fail to result in continued happiness. The failures come about partly through lack of knowledge, and partly through faults of character in either or both partners. The lack of knowledge may involve failure to understand that "falling in love" for the first time is not necessarily the serious matter it may appear to be. Many individuals upon first experiencing a sex attraction of great intensity are inclined to believe that it is the only emotion of that kind that they will ever feel, and to believe that if that romance does not culminate no other ever will come to them. They are consequently very much in earnest about it, worried about the outcome, and sometimes marry against their better judgment, on the basis of such an assumption. It is quite a mistake, usually, to believe that this sort of love can be aroused only by one individual, or that it comes only once in a lifetime. It is probably true that the attraction for some one individual will be greater than for any other, and that some one individual will represent the most suitable partner; but it is not necessarily the first individual who arouses one's emotions.

Lack of knowledge may involve also the failure to understand that marriage must be founded on more than sex attraction. In marriage there must be, primarily perhaps, sex attraction; but there must be also a different sort of liking and a rather complete intellectual accord and similarity of tastes and habits. Marriages have been successful when none of these additional factors were present; but marriages that fail often do so because of conditions quite apart from sex. Many a marriage has been wrecked by a difference in taste regarding minor matters that assume prominence in daily living. A difference in standards of expenditure may be an almost insurmountable barrier to agreeable living together. A difference in the prominence of the parental instinct and in the love for children may upset marriage.

Sex appeal, so powerful before marriage, frequently does not last against too great odds. If in other respects the marriage is satisfactory, it is likely to continue relatively so in this respect, although a different sort of love, equally satisfying, often takes the place of the earlier ardent emotion.

Fixations

The beginnings of an active emotional life are plainly seen in the normal infant. The baby is happy, and unhappy; feels likes, and dislikes; has preferences, and aversions. His emotions seem to be similar in many respects to those of adults. In the course of normal development, however, the emotions themselves develop in quality, and generally tend to be exhibited in the adult in ways that are somewhat different from those of the infant.

With respect to the emotion of love, many profound metamorphoses take place before there arises the capacity for completely disinterested love. The infant is more interested in himself and his needs than in anyone or anything else. Although he shows signs of affection for others, it seems to be largely because of what they can do for him. Time and the natural course of development change the scope of his affections. Still other changes of importance occur before love is capable of taking on its adult sex characteristics.

Even in the infant, however, there appear to be the rudiments of an interest in matters of sex. Probably this begins as a part of a general interest and curiosity about his own newly discovered body. He finds that he has fingers and toes, and enjoys playing with them. Later he also takes a similar interest in the genital organs.

A normal baby tends to outgrow this particular interest in his own body, and becomes more interested in the world about him—particularly in gaining the affection of his parents, and in giving them his affection. Sometimes, however, the stage of infantile interest and pleasure in his own body is not readily passed, and does not give place to the next stage—that of interest in others. In fact there may be a fixation at this level that lasts into adult years, producing the type of individual who is intensely self-centered, admires himself most of all, and derives the chief satisfaction of the sex instinct from himself. This is called the auto-erotic level, the term implying that the sex interest is centered in the self. The mythical Narcissus is the prototype of that level.

The habit of self-stimulation of the genital organs is called masturbation. It has long been decried as a wicked and

dangerous habit. There is a superstition that it leads to mental disease. This is not the case; it is neither the cause nor the result of mental disease. It has also been thought to be physically very injurious. While this may be the case if the habit is indulged in to great excess, it probably ordinarily does very little, if any, physical harm.

Psychologically the habit of masturbation is to some degree harmful in most individuals, however. The harm is not so much due to the habit itself as to the type of interest it represents. Bearing in mind that it represents a level of interest that is normal and natural in the baby, but one which should pass in early childhood, it will be seen that an adult whose interests are on this level will be likely not to be psychologically as well-developed a personality as one who has gone through all the stages of interest, and has reached that which characterizes the adult—that of affection for and interest in others. In its definitely sex nature, such interest on the part of the adult will be directed toward the opposite sex. The reaching of this stage of normal development is likely to be blocked if there is too long lingering at the infantile level of interest. For this reason masturbation is harmful.

Furthermore, the habit of masturbation has a harmful psychological effect in that it is usually the cause of a peculiarly oppressing, although perhaps unconscious, feeling of guilt. It is impossible to be certain to what degree this feeling of guilt is due to popular opinion regarding the injurious nature of the habit, and to what degree it is due to the underlying feeling that it represents a departure from the usual customs. Whenever an individual fails to conform to standards that society has established and that he respects, he is likely to feel some uneasiness. Whether one is conscious of it or not, the desire for social esteem is so strong in each one, that an individual cannot follow ways that he feels are different from those of most of his kind, without feeling somewhat lonely. The feeling of being "different," and the fear of the consequences to physical and mental health, combine to create a state of unhappiness and apprehension. It is in these various ways that the habit is psychologically injurious.

In order to insure full and free development, unhampered by any of the shackles of habit, it is desirable that the habit of masturbation be stopped. An individual who finds himself at the level of interest in his own body should make an effort to develop beyond this level. It should be somewhat reassuring to such an individual to realize that the cause of his tendency is merely the persistence of a sort of interest that is at one time of life essentially normal; that many other individuals are troubled as he is; that in all probability it will not do him irreparable damage, even if he fails to break away from the habit immediately and entirely; but that, with a suitable effort, it may be entirely stopped. With such an attitude of mind toward the habit, it often does cease at once automatically, without any tendency to recur. If the feeling of guilt and fear persist, the habit itself seems also to tend to persist.

The individual at the autoerotic level should seek to widen his interests beyond himself by increasing his social contacts. He should endeavor to find a sublimated level of interest in other individuals, and also in his work. Particularly should he avoid those circumstances that he may recognize as having a stimulating effect on the habit he wishes to discontinue. Not all individuals will be affected by the same stimuli. In some the stimuli will be largely psychological; in others largely physical. Whatever they may be, they may be readily recognized and avoided. A tendency to be particularly self-indulgent in regard to other pleasures derived from the body usually marks the auto-erotic individual. Like Narcissus he may take undue pleasure in contemplating his mirrored self; or have a great interest in adornment in fine raiment; or particularly enjoy luxuriating in warm rooms and in hot baths, or in other ways ministering to his own comfort. Whatever tends to counteract the tendency toward an over-appreciation of agreeable bodily sensations, will tend to have some effect in limiting auto-erotic interests.

At the time in babyhood when the interests normally tend to widen, they naturally turn first to those who are nearest—the parents or those who stand in their place. Soon they include also other children of both sexes. Still later, in the

case of girls interest is likely to become centered in other girls; and in boys, in other boys. This is the normal development of interest and affection. During the whole of life, interest in the parents remains as the background for all other affections.

The extension of interest to the other sex, which usually comes at puberty, is often merely friendliness and pleasure in companionship. Young men and young women usually interest each other very much; whereas there remains, usually, a parallel interest in those of the same sex. Although the interest in the opposite sex is quite widely distributed at first, later it tends to become centered about some one individual, and to take on a more definitely sexual character.

There are several ways in which the usual development may vary. First, a person may continue to have the general interest in the other sex with no apparent tendency for it to fix itself emotionally on any particular individual. This is a matter which usually rights itself in time. The appearance of an actual aversion for those of the opposite sex constitutes the second way in which development may vary. Because it constitutes a barrier to natural social contacts and to marriage, it is a somewhat handicapping state of affairs. A "man-hater" or a "woman-hater" is cut off from normal participation in many of the affairs of life, and may on that account never reach his own full development. An emotional attitude of this sort usually means that there exists an emotional fixation of another sort than that at the auto-erotic level. Just as there may be fixation at the infantile level of interest in one's self, so may there be a fixation at the level of interest in those of the same sex, such interest being called homosexual.

Failure to develop the usual attitude toward the opposite sex sometimes apparently occurs because the individual was environmentally so situated that the opportunities were few or unfavorable for the normal extension of interest. Sometimes it is due to early unfortunate experiences with the other sex. Often it is due to an unconscious effort to combat the newly developed interests that arise in adolescence. This is a time when many physical and mental and emotional readjustments have to be made. The body makes its adjustments

sometimes with difficulty; those of the mind and the emotions may be equally difficult. Adaptation may be made easily and naturally, or it may not be psychologically accomplished at all. It is not uncommon to find individuals having a definite dread of growing up, and of accepting the responsibilities of adult life; albeit most adults find the responsibilities more than balanced by the privileges and interests that come with them. Sometimes it is a definite fear of the sex instinct itself, perhaps because it is felt to be stronger than usual. For self-protection an individual may try to escape any situation that would further awaken it. It has been noted that many a person who at first rejects all interest in the opposite sex, swings as far in the opposite direction when he ceases to create an artificial lack of interest.

It is particularly when the emotions are rather strong, and the individual lacks the ordinary pleasures of association with the opposite sex, that he may become especially wrapped up in those of his own sex. Perhaps this interest may even become rather intense affection, demonstrated in varying degree. Such affairs among girls are called "crushes," but they have their exact analogue among men. They are more or less normal, representing as they do the persistence of a stage of somewhat restricted interest that was normal in childhood, but that should have passed. They may be exactly the same as similar affairs among children, and as harmless. In adult life they are often, however, rather different in character because of the development, to a certain degree, of adult emotions. In such circumstances they are usually looked upon as harmful to the normal development of the personality.

In "crushes" between members of the same sex, there is usually a marked dependence on the object of the affection, and a degree of jealousy that makes these affairs on the whole apparently the cause of more misery than of happiness. They are undesirable for the reason suggested—that they are not quite along the line of the best development. Nature leads individuals gradually toward a more full expression of the reproductive instinct, which is less likely to occur if the time and thoughts and affections are engaged in interests fixed at a previous stage.

It may be asserted that one stage is as satisfactory as another providing it suits the individuals concerned. The consensus of opinion is against this view. At all events the adolescent should give himself a chance to develop according to what seems to be the universal plan. Natural development entails work and play with both sexes, and the sublimation of the emotions of sex until marriage. It is rather by excluding the natural development than by anything intrinsic that these "crushes" are harmful. The strain and tension of such relationships lead most individuals to see the wisdom of abandoning them. When the sex functions are fully developed in the later years of adolescence this tendency usually passes away, and with its passing comes the easy and natural adaptation of men and women to each other on all planes of association.

MENSTRUAL HYGIENE

Whereas the preceding sections have dealt with aspects of the function of the reproductive system that are common to both men and women, this section deals with physiological functions of this system in women that have no counterpart in men. The child-bearing function of women causes the physiology of the reproductive system to be much more elaborate in them. It includes, during the period when reproduction is possible, the menstrual function. Physical inferiority has been assumed to exist in women because of the periodic recurrence of this normal function. It should be definitely stated that the menstrual function is one of the natural, normal functions of the body in the female, and that woman should be expected to suffer no incapacity of any sort thereby.

Menstruation should not be considered as a "sickness" nor as necessarily the cause of any signs of ill health. If such signs occur, it may be considered as abnormal, and as indicating the need for medical investigation, to be followed either by changes in living habits or by other treatment. There is no more reason for being resigned to the enduring of menstrual pain than to the enduring of pain from other causes. There should be no more discomfort attending the function

of menstruation than attending the function of digestion. The health of women should be unhampered in respect to the occurrence of menstruation. There should be no necessity for a period of semi-invalidism from time to time. The reliability of the health should not be impaired by the occurrence of any normal function of normal organs.

When symptoms arise as a result of menstruation they may be due to abnormality or disease of the organs involved, but they are far more commonly due only to a disturbance of their function, the organs themselves being sound. In only

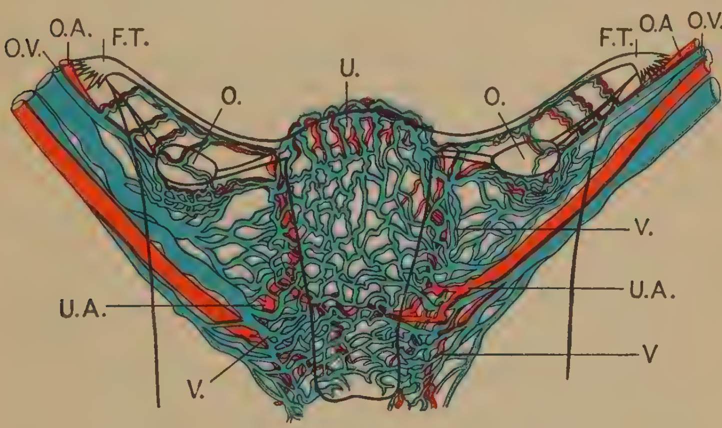


Fig. 254.—The veins of the uterus, showing congestion. u, uterus; o, ovary; f.t., fallopian tube or oviduct; o.a., ovarian artery; u.a., uterine artery; v., plexus of veins.

two per cent of a large number of cases in one group examined was there any organic disease present, or any change at all in the structure of the organs. In 98 per cent of the cases two causes in particular accounted for menstrual pain. In these cases the treatment of these two causes, or of one of them, if only one was present, resulted in the cure or great improvement of the individuals in respect to the occurrence of such pain.

The two conditions that were so commonly found as the cause of dysmenorrhoea (painful menstruation) were poor posture and constipation. Poor posture that involves a hollow back, stretched abdominal muscles and ptosis of the abdominal organs, leads almost inevitably to pressure on the

pelvic organs, and to stretching of the pelvic ligaments that hold the organs in place. They are, for the time being, crowded out of their usual position, but usually not to such a degree as to require an operation. Such posture also favors the congestion of blood in these organs, because of the impaired circulation in them. Constipation produces its results in much the same way, the overloaded colon exerting pressure and tending to interfere with circulation. The combination of poor posture and constipation is particularly likely to lead to discomfort at the menstrual periods. In a vast proportion of cases the correction of these two defects leads to greater freedom from discomfort. Pending the complete correction of them the use of a girdle at the menstrual period to help support the abdomen, and the taking of a cathartic before or at the menstrual period, are measures that are in accord with the hygiene principles involved.

Sometimes dysmenorrhoea is due to a general condition of poor health, including perhaps anemia. It has been observed that individuals who ordinarily have no trouble may be troubled after an interval of irregular living, such as impairs the health. Those who habitually "burn the candle at both ends" are likely to be subject to disorders of this sort, as well as of other sorts, that do not afflict those who arrange their lives more intelligently.

Sometimes the menstrual period does not produce local pain, but gives feelings of fatigue and lassitude and depression of spirits. It was formerly thought that this, if not pain, was inevitable. Former investigators made a point of the rhythmicity of women and their constantly being affected either by the approach of menstruation, its presence, or the recovery from it. Undoubtedly there do frequently occur bodily and mental symptoms at about the time of menstruation, as the accompaniment of the physiological adjustments that go on, but there is considerable question whether they are at all an essential part of the phenomenon. They should certainly not be very pronounced.

It will be recalled that an internal secretion of the ovary is responsible for the occurrence of menstruation. Sometimes disorders of menstrual function are due entirely to disturbed

ovarian secretion, or to disturbance in one of the other related endocrine glands—such as the thyroid. Pain, increased or decreased amount or duration of the flow, and irregularity may result thus. The securing of the normal function of these endocrine glands may be necessary before the menstrual function is normal. Sometimes the menstrual difficulty is due merely to a delay in the proper development of the organs, which time may correct.

The endocrine glands are sometimes responsible for absence of menstruation, which may or may not be due to under-development of the reproductive organs. In such a case there may be no other prominent indication of abnormal health. There are women who begin to menstruate late in youth, and who do so only at infrequent intervals, yet are in very excellent health. Even those who seldom menstruate may be capable of child-bearing.

Absolute conformity to any given standard in respect to frequency, duration and amount of flowing, is not essential for health, although whatever anomalies are present should be discussed with a physician. This should be done if only to relieve the mind of any concern about their significance—for they may mean nothing of importance.

In discussing the hygiene of the menstrual function, emphasis must be placed on the preservation of the health as a whole, as a foundation for the good functioning of the reproductive organs, as well as of all others. The fitness of the whole body—its adequate nutrition and circulation—as secured by a generally well-conducted life, is the first essential.

More specifically, what is most often needed is the relief of pelvic congestion. As has been indicated, this may be accomplished partly by correcting the posture if it is poor, and by promoting adequate intestinal elimination.

Exercise, both general and local, has an important effect in preventing pelvic congestion. General exercise benefits the circulation as a whole, and thus also the local circulation. Often all that is needed during the period is a little more exercise rather than a little less.

Special exercises are often needed. They should be of such a nature as to call into play all the abdominal muscles. Physi-

cians and physical directors usually will be able to show the individual which ones are the most effective. If this advice is not obtainable the individual may daily practice strong contraction of the abdominal muscles, both during the period and at other times. This may be advantageously done in the recumbent position, although it is to some degree effective if done in any position. For the relief of pain that is present it is often very helpful to practice this muscle contraction while lying down with a pillow under the hips. The wearing of a girdle or corset during the period, even though not worn at other times, not only helps the abdominal muscles support the organs, but serves as a reminder to contract them voluntarily.

One of the most important factors in preventing menstrual pain is a state of mind that is not apprehensive of trouble. If the individual is expecting ill health of any kind, it is more likely to arise. When dysmenorrhoea was considered inevitable, undoubtedly many individuals suffered because they expected to. Going to bed and making preparations for pain leads one to observe any minor discomforts in the first place, and to exaggerate them. Secondly, feeling that one is going to be ill and remaining quiet to limit the pain, often leads to a result exactly the opposite of that desired, for it is known that much menstrual pain is due to inactive circulation, such as lying down favors. Getting up and moving about is likely to be more beneficial, except in cases where the flowing is very free. There are some cases, of course, in which improved circulation is not all that is needed; but rather than accustoming one's self to staying in bed with a hot water bottle, and the taking of pain-relieving drugs, it would seem more rational to have the cause of the trouble sought and remedied.

Before making a local physical examination, physicians will often suggest, first, that the individual try the effect of the measures mentioned, including exercise, especially the exercises particularly planned for this purpose. In a vast number of cases, this will be all that is needed. If, after a faithful trial, no results are observed, a local examination may be necessary. When the trouble is believed to be due to defective secretion of the endocrine glands it may be remediable by medical measures. Only rarely is any sort of operation necessary.

During the menstrual period no change need be made in the ordinary routine, if the routine is a good one. Exercise may be taken as usual, if such exercise is avoided as gives undue fatigue or involves jumping or jouncing. There is no reason for avoiding walking or golf or dancing, within reasonable limits; but tennis, basket ball and horseback riding might involve a little too much jarring of the uterus, which, during the first day or two of the period is slightly heavier than usual, and in such exercise pulls upon the ligaments. Probably no harm, even from an unlimited amount of such exercise, would result in an individual in whom the ligaments holding the uterus are strong and well developed; but since those whose tissues lack tone, may have lax uterine ligaments, it is better for them, at least, to limit the sort of exercise that might involve their stretching. This advice applies particularly to the undernourished. Only those who flow rather excessively need curtail exercise further. Experience has shown that no sort of exercise during menstruation is in the slightest degree or in any way demonstrably injurious to many women.

There is an old superstition that bathing during the menstrual period is seriously harmful. There is little foundation for this belief. Bathing may and should be carried on as usual, with the exception that baths should not be too hot or too cold. Many individuals take their cold showers as usual, however, without harm. The warm tub bath is entirely safe.

It is somewhat more important to avoid unusual fatigue during the menstrual period than at other times. It is also especially important to avoid chilling by wet clothing and wet feet. The result of internal congestion by external chilling may be serious at any time, but should always be avoided during the period if possible.

The fact that fewer women of the present day suffer inconvenience from the menstrual function is probably due most of all to a change in attitude toward this function. But it is also very largely due to better habits of exercise, better posture and less constricting clothing. The health of women got its bad reputation at a time when women were inactive and improperly corsetted. Although perfection of physique and perfect mechanical use of the body has by no means been

reached, it is certain that at present posture and the use of the body is vastly better among women than it was thirty years ago. It is also certain that, with continued improvement in this direction, and with the continued activity and normal mental attitude, menstrual disorders will become more and more rare.

CHAPTER XLIV

RACE HYGIENE

When reproduction takes place the nucleus of the ovum unites with that of the sperm cell, and the zygote or single cell formed therefrom contains an equal amount of inheritance material from each parent.

The inheritance material is present in each nucleus, the male and the female, in the form of granules of chromatin. This material consists of a number of small particles called chromosomes. It is in these that all the potentially hereditary characteristics are contained. They have been in the germ and sperm cells from the time of the prenatal life of the individual who carries them, having developed with the individual. Early in the life of each animal the germ cells are set aside and the inheritance of his offspring settled once and for all. Each germ cell contains chromosomes that will determine all the hereditary characteristics of the individual, and that are thus called determiners.

The only possibilities of modification of the inheritance of the children of a given individual is by his mating with an individual who has determiners of another sort than his. The union of two cells offers possibilities for new combinations of chromosomes.

Such modification by mating is not possible in the single cell, because it merely divides into two that are of exactly the same type as the parent.

In animals, however, that have two parents, the child obtains half of his inheritance from the family of each parent. It should be noted that it is not from each parent that one gets half his inheritance, but from the family that produced each parent. A child may not greatly resemble either parent.

Each species of animal produces only animals of the same species, with many characteristics that are like that species

only and unlike other species. But each animal is slightly different from others of the same species because of variation in the combination of inheritance units. If a given species has originally some animals that have long hair and some with short, or if some of the animals are black and some brown and some white, the animals, if they varied only in respect to these

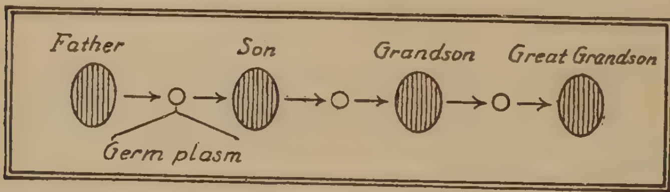


Fig. 255.—Erroneous conception of the process of heredity. (From Siemans & Barker, "Race Hygiene and Heredity." Courtesy of D. Appleton & Co., New York, Publishers.)

few characteristics, would, if mated, produce progeny of many different sorts in these respects, although all of the same species. If this species invariably had long legs, no new short-legged ones would appear in it except as the result of the mating of its members with those of a short-legged species.

Within limits, variation in individual manifestations of heredity is commonly noted. A child may, however, inherit

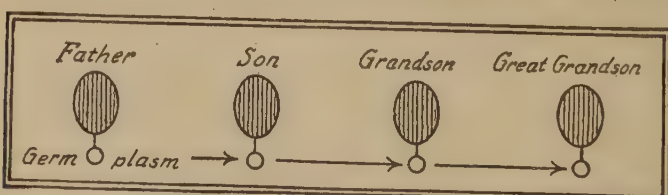


Fig. 256.—Correct conception of the process of heredity. (From Siemanns & Barker, "Race Hygiene and Heredity." Courtesy of D. Appleton & Co., New York, Publishers.)

through his parents a characteristic that did not appear in either of them, but was present in their germ plasm only, having been actually present only in the grandparent, or perhaps in an even more remote ancestor.

Characteristics that are easily recognized and may be studied easily, it is often found appear with mathematical exactness. The distribution of many traits seems to be by

chance, because most of the human traits, as for example temperament, are complex ones that cannot be easily studied from the point of view of heredity. Wherever traits are rather simple and distinct, such as eye color, it has been found that they are inherited according to a law announced by Mendel in 1886. In cultivating peas, Mendel found that from generation to generation he could predict what characteristics

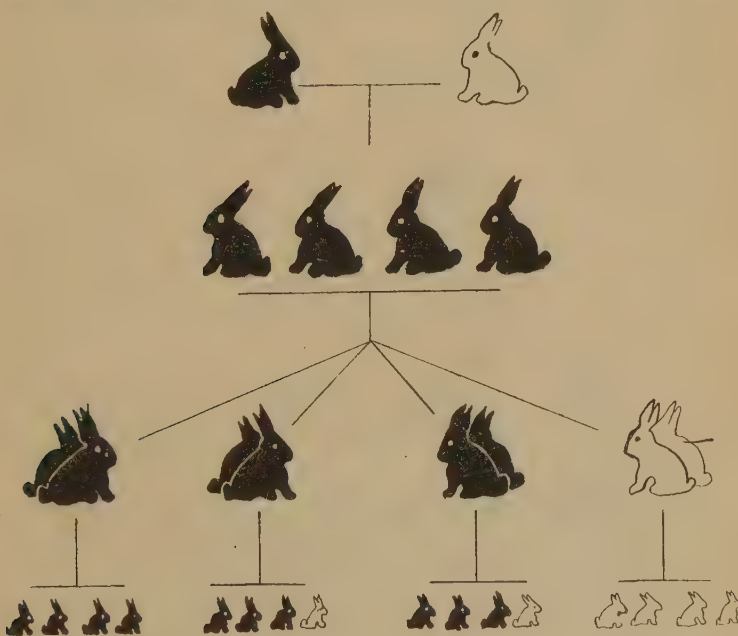


FIG. 257.—Diagram to illustrate Mendelian inheritance.

would be present in the offspring of given matings. Devries later confirmed this, and the theory has been added to by others.

One of the simplest illustrations of the Mendelian law may be observed in the result of mating animals that are black or animals that are white in color. If two black animals that have had only black ancestors are mated they will have only black offspring. If two white animals that have had only white ancestors are mated they will have only white offspring.

If, however, the black animals and the white animals are mated, they will have only offspring that are black in color, but carry in their germ plasm determiners for white color. If two of these black animals that have each had one parent that was white, and that carry therefore white determiners in their germ plasm, are mated the result will be invariably three black animals out of four, and one white animal. Of the three that are black in color, two will have white determiners and one will not. When these animals are mated their offspring will vary in color and in latent determiners for color, with mathematical regularity.

Fig. 258.—Diagram showing the course of color heredity in Andalusion fowl, in which one color does not completely dominate another. (Kellicott.)

It is probable that many human characteristics are as mathematically inherited as this. It is known to be the case in regard to certain traits, and would probably be found to be so in respect to others if all traits were as simple to study as color of hair, for example.

The enormous number of combinations in heredity is what makes the subject so difficult. But occasionally certain traits appear so regularly that they may definitely be classed as unit characteristics. Observers differ regarding what is to be included in this category. It is quite generally thought that the degree of the intelligence is definitely hereditary. Certain forms of feeble-mindedness tend to appear with great

regularity in certain families; in other families a high level of intelligence predominates. There are certain bodily traits and peculiarities that also appear with much regularity. Of these, some constitute disease, and on that account those who possess such inheritance are advised not to marry. Others, such as color-blindness and short fingers, are not in themselves more than slightly handicapping.

Race hygiene demands that considerable attention be given the matter of proper mating. The science of eugenics deals with this subject. Most of the conclusions so far reached have led to efforts to prevent from mating those who have definitely recognizable hereditary characteristics that would be detrimental to the race welfare. Certain forms of mental defect, and of blindness, and some of the diseases of the nervous system belong in this category. The work of the eugenists has so far not gone much beyond the stage of the publishing of information based on research into the extent of hereditary characteristics, and of drawing the public attention to the fact that both race welfare and individual welfare demand consideration of problems of heredity.

Before the question of marriage becomes imminent it is important that each individual have some concept of the sort of inheritance he will be likely to pass on. Such a concept should not be reached by allowing one's imagination to run rampant, or by idly accepting the statements of those not competent to form legitimate opinions. Much unhappiness could be avoided by putting the facts before someone who can give authoritative advice. It is not only in regard to one's own inheritance that advice should be had, but in regard to the inheritance of the mate. It should be borne in mind that the child is nearly as likely to resemble other members of the family as to resemble the parents.

The marriage of cousins is often unfortunate because of the fact that if two individuals have the same inheritance, and that inheritance happens to be bad, the offspring will have a double chance of inheriting the undesirable characteristics. The same reinforcement of hereditary traits by consanguineous mating occurs if the heredity is good, in which case the offspring have a double chance of a good inheritance.

Whether it is a question of relatives or not, two individuals with a similar bad inheritance, for example, color-blindness, have a much greater chance of having children with the same defect.

There are certain characteristics that are known as dominant, and others that are known as recessive. The former term means that the characteristic appears in preference to its opposite if determiners for both are present. Recessive means that if determiners for opposite traits are present, one trait —called recessive—remains latent in the individual. The black color of the animals referred to was dominant, in that it appeared in preference to white when determiners for both were present. It should therefore be borne in mind that, although an individual does not himself show a given trait that is prevalent in the family, his children may show it.

Aside from those traits that are determined by inheritance, each individual shows traits of a physical and mental sort, that he has acquired. Individuals of any species are subject to changes, within the limits established by their inheritance, in their individual lifetime. Even in the case of the simple amoeba, whose inheritance of all its characteristics is so definitely determined, it is found that not all amoebae are exactly alike. Changes superimposed on heredity produce what are called acquired characteristics. Heredity is often considered responsible for traits that are acquired. Every person represents the sum of his inheritance, plus the sum of the results of all that has happened to him from the time of his conception onward. All sorts of factors, even before birth, influence the developing individual, and help to determine what the fully developed individual shall be. Potentially he may become only what his inheritance permits. No matter how favorable the environment, the amoeba may not take on the characteristics of another species, or even become an amoeba of more than microscopic size. But within the limits fixed by inheritance, there are fairly wide possibilities of change. An individual who inherits a good mind may never have been to school, and may never have learned anything, and yet his mind is potentially as good, and he will pass on as good a mind as his inheritance permits, regardless of the training of his own.

There is one very definite conclusion reached by science—that acquired characteristics are not inherited. Countless experiments have been done with plants and lower animals. And each time it is quite clear that no matter what changes may be made in them they pass on an unchanged heredity. If the tails of mice, for many generations, were cut off, each new generation of mice would be born with the same long, tapering tail that always characterizes the mouse.

Although children do not inherit as such anything that the parents acquired, it has been observed that the very reason that the parents acquired special skill is apparently, often, that they had special hereditary aptitude, which their children may also have by inheritance. This seems to be the case, for example, with respect to musical ability. On the other hand, a parent may have passed on such ability even though he himself did not cultivate it, or perhaps have it, the special ability having "skipped" him.

The fact that acquired characteristics are not inherited, and that hereditary ones are already determined, seems to relieve an individual of any responsibility for the characteristics of his children. This is so, as far as inheritance from him is concerned; but it makes the importance of proper mating still more clear, since that constitutes the only way by which the inheritance of one's offspring may be influenced. On the other hand, there are other considerations that make desirable the acquirement during the lifetime of all possible good traits, for the sake of the effect on one's children, quite apart from any hope that such acquired traits will change their inheritance.

It is also reassuring, incidentally, with the idea of offspring in mind, that one can get results in self-development. It permits the individual to feel some satisfaction regarding the nature of the inheritance that is likely to be passed on, for able parents are likely, other things being equal, to have able children. Ability in parents may justifiably lead them to expect that their children will share in an inheritance that makes achievement possible for them.

Apart from heredity, offspring are dependent to some extent on the parents for their acquired characteristics. This is particularly true of those characteristics that arise before

birth, and are called congenital. Congenital soundness is more common than congenital disease, yet many children are born deformed or diseased because of conditions determined by the mother's health. Some of these conditions are mistakenly called hereditary because they are present before birth. There is, however, a vast difference between congenital and hereditary conditions, in that the former are, being acquired, not passed on, and are, for the same reason, theoretically and often practically preventable. The congenital diseases include most prominently various malformations, many of which are, however, inconsistent with life. A few infections are capable of being acquired by the child in utero, notably syphilis. As has been stated in a previous chapter, conditions that arise

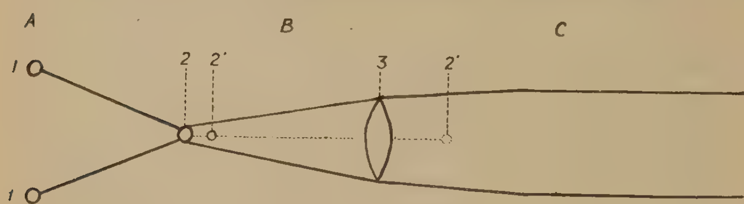


Fig. 259.—Diagram to illustrate the origin of hereditary, (A) congenital, (B) and acquired, (C) conditions. 1. germ cells of parents; 2. single cell formed by their union; 3, developed individual at birth; 2'. his germ cells, set off early in congenital period and present through life. Note that causes acting during the congenital period, B, and the individual life time, C, may affect the germ cells in some respects, although not changing the inheritance.

during prenatal life are due to physical causes and not to "maternal impressions" or "marking." They are due to one or another of the same physical causes as produce disease at any time in life. The influence of the health of the mother on the child before birth is very important. It is thought, for example, that the current mode for excessive slimness in girls, which represents malnutrition, will have an appreciable effect on the health of their children—this not because the children will inherit poor constitutions, but because they will be poorly nourished before birth by the poorly nourished mothers of the coming generation.

Even before conception, however, the germ or the sperm cell that will later take part in forming the child may be injured

while still carried in the body of the parent. It is natural that these cells should be affected at any time by that which affects the other cells of the body in which they lie. It is natural that they should share with the other cells in the adverse effects of constitutional disease or poisoning. That this is true is proved to be the case in respect to at least one disease and two sorts of poison. It is probably true in respect to still other injuring agents. The disease that affects the germ cells adversely is syphilis, and the two poisons are lead and alcohol. Even though the child be not actually infected with syphilis in intrauterine life, the germ cells from which it was formed may have had their vitality so reduced that both mentally and physically the child is inferior. Lead is a poison that is in common use in many industries. It has long been observed that women who acquire lead poisoning often are unable to bear children, because the germ cells have been rendered incapable of development. The same is true of the poison alcohol. Alcohol exerts an extremely bad effect on the germ cells in either sex. Many experiments have been done on animals of various species, and it has been observed that the offspring of alcoholized parents are often born physically and mentally less vigorous. This is known to occur in guinea pigs, and it is believed to occur in other animals and in humans. The results are believed to be particularly likely, even in the usually temperate, if alcohol was present in the body at the time when conception (union of the ovum and the spermatozoon) took place.

The harm produced in these ways in the germ cells, while they are still in the body of the parent of either sex, is called blastophthoric damage. It constitutes a considerable percentage of the causes of feebleness and low vitality, or even of frank disease. It is, after heredity, the most fundamental and serious way in which offspring may be injured. In some families the result is extinction in a few generations. If this does not occur the opposite is likely to occur, and the tendency to weakness may become increasingly less, unless added to in each generation—this because the non-resistant fail to survive and reproduce, and only those who are able to overcome the handicap perpetuate the family.

There are certain sorts of bodily and mental conditions that are not really disease but that constitute a predisposition toward it. In some families it has been noted that certain of the systems of the body are particularly prone to fail or to be faulty in their functioning. Perhaps the nervous system is most likely to be potentially easily damaged. If there exists in a family a tendency to become neurotic or "high-strung," the individuals of that family should, under guidance, so regulate their lives that conditions will be unfavorable for the weakness to appear. It is by no means inevitable that these potential weaknesses should develop.

Diseases that "run in families" laymen usually consider hereditary. Often individuals who have studied their family history are quite impressed and worried by the fact that a large number of the members of the family have died, for example, of tuberculosis or heart disease. Before concluding that there is an hereditary tendency in that direction, it is desirable to find out whether the conditions were not purely acquired ones in each instance. It is possible that a family weakness exists in respect to the respiratory tract or the circulatory system, but it is also possible that similar environmental conditions and similar habits of living were responsible for all of the cases of the same disease noted in the family. A family living closely together is likely to pass about some forms of disease by contagion, and to acquire others because they all live according to the same customs. Gastrointestinal conditions affecting a considerable number of the members of a given family may be due to the fact that all of them have the same faulty dietary habits. It is thought that the inheritance of nervous disease may often be due to the fact that parents who are nervous bring up their children in an environment that is likely to make them nervous too, rather than that their children have necessarily inherited a tendency to nervous disease.

Another cause of conditions that seem to run in families is the copying of the parents' complaints by the children. Children do not necessarily do this consciously, but because they identify themselves so fully with their loved parent, or for some other psychological reason. Without knowledge of

it, the child assumes the same aches and pains, which were real in the parent perhaps, but are often fictitious in the child. An individual who, unknown to himself, has done this, sometimes believes he has inherited the parent's ailment. One should always be a little suspicious of the validity of a symptom that exactly resembles one in a parent. Its cause in the two cases may be quite dissimilar.

The factors that determine what an individual becomes include primarily his inheritance. This may be illustrated as

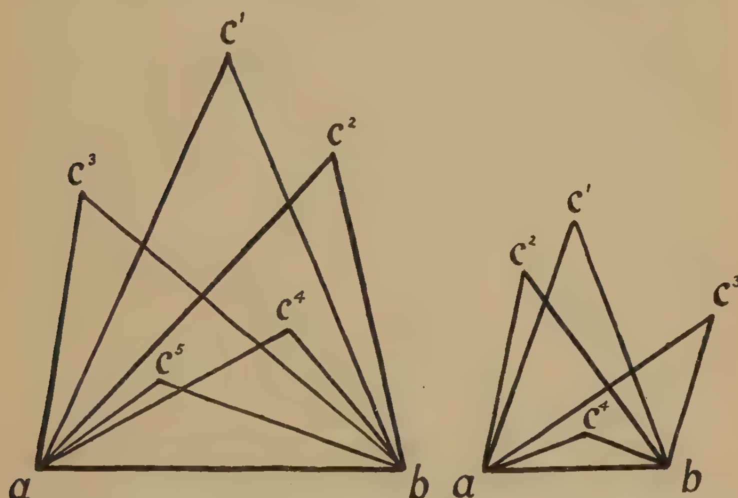


FIG. 260.—Diagrams to show the effect of environment and training in relation to heredity. *a-b*, heredity; *a-c'*, c^2, c^3, c^4, environment; *b-c'*, c^2, c^3, c^4, training. The area of the triangle depends upon the length of each line.

the base of a triangle. The two other sides of the triangle may be used to represent the two other great forces that determine the development of the individual on the basis of what he inherits—environment and training. Even with a poor inheritance, good environment and training may enable an individual to be happy and useful in life. But with the best of heredity and a poor environment and training, he may fall short of what he might have been, in fact may be an utter failure. The diagram illustrates the way in which these two factors influence achievement, given an inheritance of equal potential value.

In regard to one's own success in life, quite apart from the possibility of becoming a parent, the inheritance needs to be studied somewhat, in order to know the particular sort of environment and training one should have in order to develop to the highest level. If a poor heredity is known or suspected, still more emphasis must be placed on the other factors that determine what one shall become. Certain sorts of inheritance may be quite overshadowed by proper training and care.

All efforts should also be made by society to provide influences that will enable each individual to reach his own maximum. This is to be considered as not only for the sake of the individuals themselves, but for the sake of their children. Each parent who reaches a high level of achievement enables his children, not, of course, to inherit his power, but to profit in various ways through the achievement itself. It is better for children that parents should go as far as their heredity permits in attaining health or education or position. It is also for the sake of the social well-being that individuals should be enabled to achieve what they can, and for the social well-being of the next generation as well as of the present one.

The social conditions that the society of one generation passes on to the next is called the social inheritance. It includes the standards of all sorts, the habits and customs, the laws and the government, that one generation receives from the preceding one, modifies to meet its needs, and passes on to the succeeding one. The social inheritance is dependent on the qualities possessed by the individuals who make up society, and society profits by the advance of each of its members. Some of those who do not affect the biological inheritance, since they do not become parents, may, in this way, affect the social inheritance of the race, for better or worse.

There is really no argument possible about the relative importance of heredity, environment and training, although the question is constantly being raised. Whereas the ideal would be the birth of a larger proportion of individuals of sound stock, physically and mentally able to look out for themselves and to contribute to the welfare of the race, it is inevitable that most of the individuals of inferior stock in each generation, and often also some of those of superior stock, shall mate with inferiors.

It seems also to be inevitable that not all of those who are capable of passing on a sound inheritance shall have children. It is Utopian to look forward at once to such an increase in the knowledge regarding inheritance as will greatly increase the number of biologically successful matings. Nevertheless little by little it is to be expected that the intelligent will learn to consider biological principles, both in their own mating and in respect to the problem as it presents itself in educational, social and legal matters.

Pending a time, in the far future, when matings shall more often be such as to secure to the offspring a favorable inheritance, the present of each generation demands that whatever the inheritance of its individual members may be, their realized achievement be as high as possible.

CHAPTER XLV

THE HYGIENE OF THE EYE

Of all parts of the body under voluntary control the eyes are the hardest worked. Even quite small children have tasks both at home and at school and engage in varieties of recreation that demand much work of the eyes at close range. Adults use the eyes for close work often for as many as eight or nine hours a day at work, and for another three or four hours in recreation. When the body is so tired that one must call the day over and go to bed, it is not unusual to ask the eyes to go on working a bit longer while one waits for sleep by reading in bed.

In the case of children, it is doubtful whether so much close work is desirable. Certainly it is not desirable unless the eyes of the child are in good condition and unless they are used under the most favorable circumstances. In the case of adults, however, it is possible to use the eyes as much as they often are used, without precipitating any trouble, even though the eyes be not absolutely perfect to start with. The eyes usually will give a lifetime of service, even of very hard service, if they are given a chance—that is, if they receive ordinary care.

The eyes are more subject to imperfections in structure than are most parts of the body. Hereditary eye imperfections are not infrequent. Congenital ones are common, comprising most of the eye defects that occasion the need of glasses. Such defects are often the cause of no trouble if the eyes have proper treatment through life. It is to prevent congenital defects from giving trouble, and to prevent acquiring defects, that the hygiene of the eye must be studied.

Fortunately, the eye is better understood than many of the parts of the body. It is so well understood that it is possible to counteract the effects of congenital eye defects, and to get almost perfect use of what would in former centuries have been hopelessly imperfect eyes. Furthermore, it is possible, by

regulating the conditions of use, to prolong the daily period of eye work, and to prolong the period of life during which good vision may be expected.

In the case of the vast majority of individuals there is no objection to using the eyes practically all one's waking hours, even for close work most of that time, if the conditions under which the eyes are used are favorable. Only a few individuals need to limit their work out of consideration for the eyes, and most of these need not have arrived at the point of having to do so had they all along been particular to avoid definite abuse of the eyes.

Few eyes are absolutely normal as optical apparatuses. Few give entirely normal vision for all purposes. But most eyes can be made to provide perfect vision for all purposes by supplying them with correcting lenses placed in front of the lens of the eye, to counteract the refractive error produced by the faulty shape of the eye itself.

In counting on heavy use of the eyes, the optical effectiveness of the eye should first be determined, and any lack of satisfactory function corrected. One may then use the eyes almost without limit, if reasonable conditions are maintained. It is not always safe to refrain only from that use of the eye which the eye itself plainly announces is abuse. Because of the possibility of referred or reflex symptoms due to straining of the eyes, one does not ordinarily conclude that the eyes are not being abused because they do not proclaim it. Furthermore, one does not usually wait to see whether certain kinds of eye use are going to harm them, because of the fact that symptoms often do not appear until irreparable damage has already been done. Although it has been mentioned that the eyes are easily protected from harm, it should also be mentioned that they are most readily harmed.

The care of the eyes involves, as does that of any part of the body or any of the body functions, the care of the health as a whole. The effect of the general health on the eyes is shown plainly in their appearance as well as their visual function. The difference in appearance of the eyes during illness or at a time of fatigue is often so marked that friends comment on it and gauge their sympathy somewhat by what they see in the

eyes. A clear, sparkling eye is seldom found in those who do not get enough sleep, for example. If there is any weakness of the eye muscles or any optical defect, it is always more pronounced when the health is below par.

The hygiene of the eye includes both general hygiene and that of the eye itself. It does not entail the use of lotions, or drops, or ointments, or hot or cold compresses, or eye cups, or massage of the eyes, unless these measures have been advised for one's personal needs. If the eyes feel uncomfortable, a physician should be consulted. Under unusual circumstances of exposure to dust a few drops of 4 per cent boracic acid solution may safely be used, but not for the purpose of postponing consultation regarding any inflammation of the eyes. As in respect to many medicines, it would not be harmful in itself, but might interfere with getting treatment of another sort that was urgently needed.

Certain forms of injury to the eyes must be avoided. Eyes may be harmed by any of the usual causes of disease, which include, as always, infection, trauma and poisons.

Infection of the eye or its lids comes about either by means of germ-laden dust, fingers or handkerchiefs; or by extension from other infected parts of the body. Sometimes it is the accompaniment of a cold. It is less likely in those who are careful not to rub the eyes or touch them with the fingers.

The main signs of infection are redness and swelling, unpleasant feelings and increased secretion. The commonest sort is called "pink eye." Because it is contagious and because it may indicate serious eye disease, it should be promptly attended to. One of the least serious results of neglecting it is a possible falling out of the eyelashes. The most serious result is, of course, blindness. It consists of an inflammation of the membrane covering the eyeball and lining the lids, the conjunctiva; hence its technical name, conjunctivitis.

Sometimes conjunctivitis is not of the contagious variety, but equally serious to the individual who has it. This may be the case when it is an indication of eye strain or of disease of some important part of the eye. Mere irritation from dust and chemicals may produce a condition that closely resembles the more serious forms of inflammation.

Blepharitis is inflammation of the lids only. It, too, is often due to eye strain. Besides being red, the lids may be swollen and produce more secretion than usual.

A stye is an inflammation of one of the small glands along the margin of the lid that produce the oily secretion that moistens the lid. The bacteria that cause it are usually carried into the duct opening by rubbing or scratching the eyelid, but eyes that are subject to strain and are congested seem much more likely to be thus infected. There is an absurd superstition to the effect that styes are of no significance. They have the same significance as any infection has. They may go away without treatment, but usually they must be opened in order to get rid of the pus and to prevent further infection. An individual subject to styes should always have the eyes examined.

Dark circles about the eyes indicate, first, that the skin there is quite thin, and, second, that the circulation is not active there. The combination results in the dark venous blood showing through the skin. It is often found in those whose health is poor, and whose circulation is not good. Dark circle are due more often to lack of exercise and lack of sleep than to any other causes. There is no connection between them and any particular form of dissipation, for bad health habits of many kinds may show thus.

Trauma of the eye is most commonly of the sort to be classed as simple irritation, such as is caused by dust, face powder, smoke or soapsuds. There is a reflex increase of tears in the eyes when irritants arrive, which tend to wash the irritant away, the excess of tears passing off through the nose usually. If the irritant is extreme or often repeated, conjunctivitis may follow.

Occasionally larger particles of foreign matter get in the eyes. Even very small particles may feel like cobblestones on the conjunctiva, because it is very sensitive. The foreign particle is often washed away by tears as other irritants are, if no efforts are made to remove it beyond closing the eyes and waiting for this to happen. If the eye is rubbed, in an effort to dislodge the particle, much irritation may be caused. Many of those who present themselves to have particles

removed from the eye are suffering at the time only from the soreness produced by rubbing the eye. This is a dangerous thing to do because the particle may be pushed along the eyeball and cause considerable damage, with possible later infection. If, after an interval of waiting for the particle to be dislodged by tears, it is still there, one may remove it, if it is to be seen, by very gently brushing a bit of cotton or the corner of a fresh handkerchief over it. If it is not to be seen, a physician should make the search for it, rather than obliging bystanders. The same is true if it is visible but does not move readily. If one's own efforts are successful a few drops of 4 per cent boric acid solution may be dropped into the eye afterward.

The chief poisoning of the eye to be avoided is that caused by wood alcohol, which may result from drinking beverages of unknown composition. Rarely substances put on the hair contain this or other chemicals capable of causing blindness.

The care of the eyes involves primarily, however, the avoidance of functional abuse of them.

First, may be mentioned, to be condemned, the habit of holding objects too near to the eye to increase their visibility. Reading distance should be properly about 12–14 inches. Except in the myopics there is strain of the ciliary muscle in looking at an object held nearer to the eyes than that. In them, even, it increases the strain of muscles that enable the eyes to converge on an object and produces congestion of the eyes.

Second, one should avoid reading or using the eyes with the head bent forward. This also causes congestion. In microscope work this is unavoidable, but harm may be avoided by not doing all of the forward bending at the neck, and by occasionally raising the head. Books should be horizontal to the eye as far as possible.

Third, it is undesirable to look too much at rapidly moving objects, especially small print on a moving train. Headache and dizziness may result. The harm to the eyes from looking at flickering moving pictures may be lessened by sitting far back in the theatre.

Fourth, reading in a recumbent posture for a long period usually causes strain and redness of the eyes. This is partly

due to the congestion from the posture of the head, partly to strain of the eye muscles in looking downward, and partly to the fact that the light is seldom suitably situated. Furthermore, if done at night it often keeps one awake longer than is desirable. All these factors produce more pronounced results when one is already tired or ill. If the book is propped up to be on a level with the eyes and the body in a semi-sitting position, and the light at the head of the bed, the harm is less.

Fifth, excessive use of the eyes for near work may cause strain even in normal eyes, although it is much less likely than in defective eyes not properly equipped with glasses. Variety in the use of the eyes is beneficial to them. One of the good effects of outdoor exercise is that it both directly and indirectly helps the eyes—directly, by permitting long range vision; indirectly, by benefitting the general health. In considering the variety of recreation chosen, the relief of the eyes should be taken into consideration to some extent.

Sixth, the light should always be arranged in such a way as to make vision easy without irritating the eye by its glare. The light in a room should be daylight if possible, or artificial light that most nearly resembles it in all respects.

When daylight is used, the important thing is to see that it sufficiently illuminates the object looked at. The sun should not be permitted to shine directly on the object, nor yet directly into the eyes. The furniture should be arranged so that one does not face the light, and so that the objects looked at are neither in sunlight nor shadow. Either is a strain to the eyes. So far as possible, light should fall over the left shoulder upon one's work, so that the right arm will not cast shadows in writing. The bed should be so placed that the early morning sun from an east window will not shine directly into the eyes.

When artificial light is used, the same rules apply. Electric light is best because it is more nearly like daylight in brightness and steadiness. Gas is next best, providing mantles are used; otherwise it is a flickering light. Its effect on the air is more objectionable than electric light. Lamps and candles are open to the same criticisms to a greater degree.

No unshaded lights should be used. The eye is affected, as well as the whole nervous system perhaps, by having uncovered bulbs or flickering, unshaded candles in the line of vision.

The most modern way of lighting public buildings is by indirect light. This provides an opaque shade below the light, the bulbs themselves being placed near the ceiling, whence the light is dispersed throughout the room. Semi-indirect lighting, which is next best, provides a semi-opaque shade, but even such a light should be outside the range of vision.

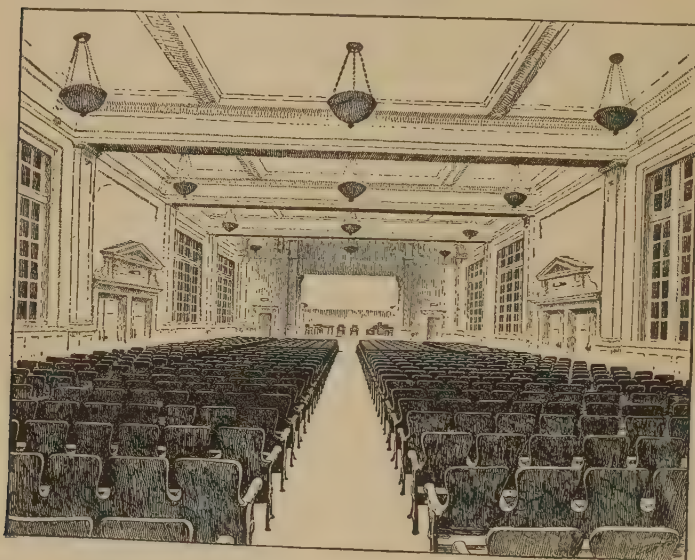


FIG 261.—Indirect lighting without glare. (From Williams, "Healthful Living." By permission of The Macmillan Company, Publishers.)

In homes the lights are usually covered with semi-opaque shades, and arranged so that they cast light on various spots where light is needed. In addition to this there may be in the room other shaded lights, intended to give a diffuse light. Working lights may safely be placed in front of one rather than to the left side if the bulb itself is fully covered by an opaque shade. The desk lamp, green on the outside and white on the inside, is satisfactory if none of the bulb is visible, and if it is not so near the work as to make it too dazzling. If

glazed paper is being looked at, this glare must be carefully guarded against. At the same time, shadows on the work must be avoided. If it can be avoided, the room in which one is working should not be a mixture of gloom and glare.

Color is a variety of light. The furnishings of a room thus may be such as to produce eye strain by excess or lack of light. Very light-colored or glistening wall papers are as injurious as extremely dark ones. Neutral, dull walls of a light tint are to be preferred. They increase the amount of sunlight and make less artificial light necessary. Very light colors or very distinct patterns are fatiguing to the eyes and nerves.

Outdoor light may be a strain on the eyes, especially on blue eyes, through which more light enters than through brown ones. It ought never to be necessary to do more to protect the eyes than to wear a hat when the sun is very strong, unless the eyes are abnormal. Before adopting tinted glasses when the sun shines on the snow or at any other time, an oculist should be consulted.

It is unfortunate that disturbance of function of one organ so often gives symptoms not in that organ but in another. Had Carlyle known at the age of twenty-three that the dyspepsia that began then and never completely left him, although he lived to be eighty-five, was, as opthalmologists believe, due to eye strain, he might have been spared much misery. Huxley, Darwin and DeQuincey, it has been suggested, suffered from their well-known ill health on account of poor eyes. Until recent times it was not realized that any symptoms except reduced vision were attributable to defective eyes. Even now, sometimes individuals assert that because they can see well they do not need glasses.

Yet it is thoroughly established that eye strain may lead to many symptoms remote from the eyes, while vision seems normal and no discomfort is felt in the eyes themselves. The commonest symptoms are headache, nausea, dizziness, indigestion, irritability, nervousness, drowsiness, and inability to concentrate the attention for long on mental work. Sometimes the necessity for long hours of sleep may be due to the necessity for a long recuperative period on the part of strained eyes. Sometimes the reverse, insomnia, is present. "Nervous

breakdown" has been found in some cases to be due solely to eye strain.

Local symptoms in the eye are often present, too. The chief of these is likely to be an appearance of strain, which is apparent often to others than trained observers. There is often a harassed, anxious expression; sometimes "shifty" eyes; often a staring, uneasy expression. Glasses may be "disfiguring," as they are sometimes called, but they are less so than the unbeautiful appearance of strain. In addition, such eyes are often slightly reddened at the lid margins, and on the "white" of the eye, and are often slightly "watery" in appearance, or else hard and dry. Finally, there are often wrinkles in the forehead and about the eyes, produced by the effort to get the proper focus on objects.

The individual with strained eyes may find that they pain or itch or burn, or that the lids twitch, or that he is sensitive to light, or subject to styes. With these symptoms there may be no disturbance of vision, or merely occasional blurring or dimness of vision.

The causes of eye strain are chiefly uncorrected refractive errors. The individual needs glasses and may not know it. But it may occur in normal eyes badly used in some of the ways suggested. Not rarely the eyes would not suffer from strain, even under the unfavorable use given them, if the general health were better, or if some particular form of ill health were not present (e.g. sinus disease).

Formerly glasses were worn only when vision was obviously defective. Now they are worn often by those with slight eye defects to prevent future impairment or possible loss of vision; and also to prevent the state of nerve strain and bodily ill health that so often accompanies eye strain.

Those who need them but will not wear them fail to do so either from vanity, or from the mistaken belief that they weaken the eyes, so that once worn they must always be worn. This principle—that all sorts of crutches should be avoided—is a good one; but it does not apply in respect to the eye. Sometimes the temporary use of glasses helps the eyes, so that the glasses may later be given up. They never make the eyes actually weaker.

There are those who will not have their eyes examined because they believe glasses will surely be prescribed anyhow. This, of course, is not true, for not all individuals need glasses by any means.

Those who most need glasses are the nearsighted, although they see near objects well and do not miss the clear distant vision they lack. They need glasses for near work to prevent damage to the eyes, but usually they also prefer them for distance too, although the eyes are not harmed by failure to use them then. The farsighted and the astigmatic need glasses all the time. Those whose two eyes are different also need them all the time, to prevent strain on the stronger, and weakening of the weaker, eye. Every individual should have the eyes examined before undertaking any very great amount of close use of the eyes.

There is some popular misunderstanding, which should be cleared up, about the various kinds of individuals who have to do with providing glasses. First, there is the physician who has studied medicine and has then specialized in eye conditions. He is called an ophthalmologist or oculist. Because he knows the whole body, he is the best able to make a correct estimate of the status of the eye and its relation to health. Physicians do not advertise and do not announce themselves as "Eye Specialists." The best way to find out which physicians are specialists in the eye, is to inquire from any reputable physician in the community, or find out who has charge of the eye work in the best local hospital. Physicians write prescriptions for glasses, just as they do for drugs. The prescriptions are to be filled by opticians.

There are also optometrists, whose study has been largely that of the eye itself. As their name indicates, they "measure" the eye for refractive errors. The optometrist, who is not a physician, will examine the eye itself satisfactorily, but the consideration of it in relation to the general health or problems of disease is not within his scope.

Finally, there are opticians, whose business is that of grinding lenses and making and fitting glasses. This is a very important part of the work of getting an individual's refractive error corrected—so important that the optician usually

devotes his whole attention to receiving prescriptions from physicians and filling them in the best manner possible. But individuals often demand of them eye tests, in order to save the expense of an examination by a physician. Opticians are able to determine what glasses enable an individual to see test types, but beyond that they usually do not go. It sometimes happens that a more full examination would have revealed reasons against the glasses that seem to be satisfactory, or would have suggested other treatment than glasses.

The physician who examines eyes sometimes finds it necessary to do away with the action of the muscles of accommodation temporarily by the use of drops of belladonna or atropine. There is danger in using such drops in certain diseases of the eye, hence they may not be used by any but physicians, who will not use them except when they know them to be, as they usually are, absolutely safe. They make near vision impossible for a few days, but the action of the muscle always returns to its former status, and vision is restored. Those who are not permitted to use drops sometimes speak of them as though they were always dangerous.

After the physician has given the prescription and the optician has filled it, the glasses should always be taken back to the physician for his final verdict on their suitability.

It may be found that the glasses change vision so much that they are uncomfortable, cause dizziness, make the floor seem too near or too far, limit distant vision, and make things appear crooked. The physician should be consulted about any apparent failure of the glasses to do their work. Sometimes he will make a change, but usually he will recommend a further effort to become used to them, after which one should expect improved vision. It is possible to get so used to poor vision that it takes some time to adjust to good vision. If one selected one's own glasses by trying on various pairs, one would usually be wrong.

The frames and the nose pieces are almost as important as the lenses themselves, since they serve to hold the lens in the proper location in front of the eye. A slight misplacement may do away with all the value of the lens, especially if

the defect is astigmatism. The lens should not be placed so near the eye as to rest against the lashes.

The eyes should be reëxamined after any serious illness or any marked change in the occupation, if it involves change in the use of the eyes.

There are many sorts of fake eye specialists that may or may not belong to any of the classes mentioned. Whenever a money-making atmosphere prevails, devotion to science may be presumed to be absent. And whenever a form of treatment is diametrically opposed to all the principles of science as at present recognized, the one who practices it may be suspected of being either a fool or a knave. Although it is relatively easy to keep the eyes in health through life, the measures used to this end must be in accord with, rather than in violation of, the principles of science.

CHAPTER XLVI

THE HYGIENE OF THE EAR

It is important that the hygiene of the ear be understood, because defects in the organ of hearing are very often due to lack of care. Deafness in one or both ears is very common, and a large proportion of it is of a preventable sort. In the case of the ear, it is scarcely a question of overuse, as it is with the eye. The only individuals whose ears are affected in this way are those, such as boiler-makers, who work in very noisy places. The constant hearing of extremely loud noises for long periods may in time dull the sense of hearing for ordinary sounds. Ear hygiene does not usually involve prevention of fatigue or strain of the ear, but is most often a matter of the avoidance of infection.

Only a relatively small proportion of the cases of deafness are due to disease of the inner ear structures or of the auditory nerve itself, or of the sound perceiving centers in the brain. The majority of the cases of deafness are due to the results of disease of the sound-conducting apparatus of the middle ear. The care of the ear involves chiefly the protection of these structures against injury or disease, chiefly against that due to infection. There is nothing at all that need be done to the ear itself in the way of daily care.

The important middle ear is approached from two directions: from the exterior, by the external auditory canal; and from the throat, by the Eustachian or auditory tube. These two paths to the ear should be prevented from becoming the route whereby infection reaches the ear. At the inner end of the canal there is located the drum membrane which ordinarily effectively prevents the entrance of any foreign substance, including bacteria, into the ear. The auditory tube has, however, free communication with the middle ear. It is by the latter route, therefore, that most middle ear infection

arises. The mucous lining of the middle ear is continuous with that of the nose and the throat, and bacteria that thrive in these areas will find as favorable conditions in the ear, to which they have free access through the short auditory tube.

An acute middle ear infection is a common complication of scarlet fever, but it often occurs in other infections of the nose and throat, even in ordinary colds. When this happens there is an accumulation of purulent secretion in the cavity of the middle ear, which causes pressure on the drum membrane, and is likely to cause it to rupture. This condition is known as an abscess in the middle ear. There is intense pain while the pressure is great, which, however, is immediately relieved if the drum membrane ruptures spontaneously or is punctured by a physician. If there is delay in the escape of the pus, it may spread from the middle ear to the mastoid cells in the bone near by, and their drainage, by a surgical operation, be made necessary.

Following an ear abscess that receives prompt treatment it is expected that the mucous membrane in the middle ear will be restored to normal and that the drum membrane will heal, hearing being restored completely. Sometimes, however, healing is delayed, or perhaps fails to occur, in which case there is chronic infection of the middle ear, that needs medical observation from time to time, and treatment occasionally. Such a condition also calls for special care on the part of the individual so afflicted, in order to avoid a renewed acute infection, or more serious complications.

Sometimes the acute infection subsides and the mucous membrane heals, but the opening through the drum membrane fails to repair. This constitutes a perforated ear drum. The drum membrane is occasionally ruptured by accident, such as blows on the ear, or by implements inserted into the ear in misguided attempts to clean the canal. Its perforation is far more likely to occur as the result of disease of the middle ear. As has been stated, it tends to repair unless the fluid that ruptured it contained bacteria that infected its edges, such infection being pronounced in degree and prolonged.

A drum membrane that has been ruptured and has not regrown, may lead to deafness or not, as the case may be. Ordi-

narily it produces at least some degree of impairment of hearing. A perforated drum membrane always leads to greater susceptibility of the middle ear to infection thereafter. The individual possessing it has to use special precautions against infection of the middle ear from the exterior, since the usual safeguard, an intact, protective drum membrane, is missing. Even the entrance of water into the ear under such circumstances is likely to be dangerous.

If the drum membrane is not known to be sound, circumstances should be avoided that will lead to water getting into the ear. It is a simple matter to have the ears examined before engaging in water sports; and it may save much trouble to be guided by advice on this matter. Twenty-five per cent of adults have or have had perforated drums, many of whom never suspected it. If the perforation has healed, there is of course no danger of water entering the ear by this route, although the condition might have some significance in indicating a greater likelihood of the middle ear to a repetition of the infection. A considerable proportion of ear disease in adults is due to conditions that could have been prevented, had the state of the drum membrane and the middle ear been known.

Occasionally during a cold there will be congestion of the Eustachian tube and of the mucous membrane of the middle ear, without infection. The structures are swollen and give pain, and some impairment of hearing, which is usually described as a "dull" or "stuffy" feeling in the side of the head. An increased amount of mucus is formed in the middle ear, which may be prevented from draining away because of the swelling of the tube, through which it usually has its exit. The drum membrane may rupture under such circumstances, and a watery fluid be discharged, after which the membrane heals.

Swelling of the tube during a cold may lead merely to a change of atmospheric pressure in the middle ear—such as is experienced in high altitudes—producing the same sensation of "dullness" and slightly impaired hearing. This disappears when the swelling of the tube subsides. Sometimes the tube is chronically closed either by its chronic swelling or by the pres-

sure of adenoids against the opening of the tube. There is then likely to be some degree of chronic deafness, because of interference with the vibration of the structures in the middle ear, due to the changed conditions there.

The prevention of middle ear diseases consists almost entirely of the prevention of nose and throat infections, and the immediate attention to those that do arise. It also involves the clearing up, if possible, of any chronic ailments of the nose and throat. The existence of a deviated septum, enlarged turbinate bones, adenoids, or enlarged or infected tonsils may constitute danger to the ear.

Bacteria from the throat may travel to the ear without assistance, but they are often forced through the tube by efforts at ridding the nose of secretions. In blowing the nose, especially during a cold, great care should be taken to expel the secretions through the nose, rather than forcing them into the ear, which is likely to happen if the mouth is kept closed and one nostril held tightly. There may be a sensation in the ear at once, that indicates that it has been filled with secretion. Snuffing presumably antiseptic solutions up the nose may give the same result, the bacteria being drawn backward toward the Eustachian tube and then forced into it and perhaps also into the openings of the sinuses. The careless use of nasal douches has undoubtedly caused much ear trouble. They should be used only when advised by a physician, and strictly according to directions. After getting water into the nose, as in swimming and diving, it should be blown out quickly, before an inward breath is taken.

As has been mentioned, those with chronic middle ear disease, or perforated drum membranes or even with susceptible middle ears, should not go into the water. The fallacy of expecting to protect the middle ear by plugging the external canal to it is apparent when it is realized that there is another entrance to it, even more favorable than that of the canal. The ear is similar to the sinuses in respect to its accessibility to bacteria from the nose and throat.

The middle ear is sometimes rendered more susceptible to infection by the effect of chilling. A strong draught blowing on the ear, even indoors while sitting still or lying in bed, may

constitute a danger. Sitting still outdoors, especially while driving in a cold wind or rain, may also be hazardous, particularly for the individual who is susceptible to ear trouble.

The external auditory meatus, the canal to the middle ear, should need no attention. It is practically self-cleaning. The cerumen that is produced there should dry and be shed as flakes. Those with oily skins sometimes have an excess of cerumen, which may be removed by winding cotton on a match and gently rotating it in the canal. No other implement should ever be used. Unless care is used, by putting the match in the center of the canal and then pulling outward, the cerumen may be pushed farther in, accumulate next the ear drum, give slight deafness, earache or "noises," and sometimes dizziness and nausea. Cerumen that has been pushed inward against the drum should be removed by a physician. Deafness only apparent after getting water in the ear or on damp days may be due to this cause. The canal may be infected by efforts at cleaning it, especially if the finger is used. Boils in the canal may result, which are quite painful because the tissue there is so dense. If foreign bodies get into the canal by chance, they should be removed by a physician, because inexpert efforts may result in damage of the drum membrane.

The inner ear, which contains the end organs of the auditory nerve and of the nerve that has to do with the maintenance of equilibrium, is sometimes involved in middle ear disease, but it is relatively well-protected against harm. From the point of view of hygiene it needs no consideration beyond that given to the middle ear, and that which involves the prevention of general infection of the body, such as might localize itself there.

Deafness should not be accepted by the deaf as inevitable until examinations for its cause have been made, and any treatment instituted that might improve it or prevent it from becoming worse. There is often much that may be done in the latter direction.

CHAPTER XLVII

ALCOHOL AND HABIT-FORMING DRUGS

Alcohol is both a food, a medicine and a habit-forming drug. Its use as a food is limited practically to the feeble and the aged. As a drug, it is used as a transitory stimulant. Its effect, after the first half hour or so, is certainly, however, narcotic or "sleep-producing." It resembles in its action ether and chloroform, and has been used for similar purposes before the more powerful narcotics were discovered. Alcohol is used somewhat by physicians for various medical purposes, but its general use in medicine was formerly much greater than at present. Alcohol has always been taken much more for psychological and social reasons than for any other.

The production of alcohol occurs in nature whenever sweet liquids stand for some time so that they ferment. In this way, a fluid containing one to fifteen per cent of alcohol is formed. This process was known to primitive tribes everywhere. The alcoholic beverages are some of them produced in this way, but the invention of the still made it possible to produce beverages of much higher alcoholic content. Before physiology was well understood, certain results of the drinking of alcoholic beverages were misleading, and they were thought to be capable of magical enhancement of all the values of life. It is now realized quite generally that over-indulgence in alcohol is incompatible with the best health, and that overindulgence is a common sequence of moderate indulgence.

The effect of alcohol in small amounts is that of a slight stimulation of the gastric mucous membrane, that may amount to irritation, and the reflex stimulation of the heart and the nervous system temporarily. The activation of the heart may be of the nature of lessened inhibition. Alcohol is quickly absorbed and oxidized, in small quantities replacing carbohydrates and fats as fuel foods, and contributing to the

available energy. If taken in large quantities, it is not itself stored as fat, but, by being oxidized instead of food, it enables the food to be deposited as fat in larger proportions than usual. It is not a substance to be added to the dietary however, since, besides acting as a food, in more than very small quantities it acts as a poison by combining with the organs, to the detriment of their structure and function.

When even a small amount of alcohol is taken, there is a superficial dilatation of the blood vessels of the skin, while the interior of the body is cooled. Through the sensory nerves in the skin a feeling of warmth is experienced, because the skin is warm. But the body is actually cooler. In summer, because of the increased surface heat, alcohol predisposes to bad effects from heat or the sun. In winter, because of the cooling of the interior, and also by the loss of heat from the superficial capillaries, it predisposes to the bad effects of exposure to cold.

In small amounts, alcohol also has certain effects on the brain and the nerves. Even a little alcohol interferes so much with muscle coördination, acuteness of the senses and stability of the nerves and the brain, that most industrial employers, for example, do not approve of workers indulging at all, or at least not in working hours.

By stimulating the gastric flow, a small amount of alcohol improves appetite, but it tends to slow the action of the gastric and intestinal secretions on the food, so that digestion is often not so satisfactory. By lessening the sense of fatigue, a small amount of alcohol may lead to activity that dangerously increases fatigue while the individual is unaware of it.

As is the case with all narcotics, alcohol tends to take away first those higher powers of the brain that have been last added to the equipment of civilized man, and that represent the climax of mental power—such faculties as attention, judgment, and discrimination. Although the mental power is the same, it is not used as well. Accuracy of mental work is decreased, as well as speed, although usually the individual would say that all these qualities were present in higher degree.

Among the prominent effects of even a small amount of alcohol is the lessening of the power of inhibition usually

imposed by consciousness on the unconscious or instinctive tendencies. This may be perceived to a minor degree in the increased ability of the individual to take part in conversation. The tongue-tied may become loquacious, and the reserved, sociable. The individual often appears to himself to be brilliant and witty; to others he may appear merely excited or confused. Natural crudeness often may be hidden until such time as alcohol loosens the bonds that restrain it. Primitive manifestations of instinct become easier than the more civilized forms. Conduct an individual would ordinarily consider reprehensible may seem praiseworthy, attractive and safe. The relationship between alcohol and the sort of conduct that leads to venereal disease is very close.

The effect of a large amount of alcohol at one time is an acute poisoning. Many functions are disturbed. Incoherence, delirium, stupor and perhaps death occur. A single large dose may, however, in the digestive upset that often occurs, be automatically gotten rid of before such results occur. There is a tendency for some individuals to become periodically "drunk." This is a disease called dipsomania. When the individual is badly poisoned, medical attention may be needed, although if not too severe, the effects usually pass off after the long sleep that follows. One usually suffers no great harm by a single poisoning of this sort, but only by repeated poisoning.

The effect of large amounts of alcohol over a considerable period of time, or even of relatively small amounts, is a chronic poisoning. It is this that is the chief danger to health.

In chronic poisoning by alcohol, the individual may never have been acutely poisoned at all, or he may have a history of repeated attacks. The manifestations of chronic poisoning may or may not include indications of temporary excess in the way of attacks of delirium. Often there has been no excess at any time, the effects being cumulative as the result of relatively small amounts for years.

In order to enumerate the organs that are affected by chronic poisoning, it would be necessary to enumerate most of the organs of the body. Those that are most commonly and most seriously involved include the heart and blood vessels,

that in turn involve many of the organs that depend on them for nourishment. The lungs are made less resistant to infection—pneumonia and tuberculosis being very common and peculiarly fatal in the chronic alcoholic.

The most serious effect of all is produced, however, on the nerves and the brain. The nerves to some degree lose

FIG. 262.—Brain cells deteriorated by chronic alcohol poisoning. (From Williams, "Healthful Living." By permission of The Macmillan Company, Publishers.)

their conducting power, and the disturbance of the brain may result in what is legally known as insanity. Psychiatrists are most interested in the prevention of chronic alcohol poisoning for this reason. Short of mental disease, there are often pronounced changes of disposition.

The poisonous effect is especially seen in respect to any and all epithelial and nerve tissue, which undergo slow degeneration. There is also a tendency for the proper cells of a part to be replaced by fibrous or fatty tissue.

If death is not due to other causes, which is likely, since the alcoholic is not long-lived, the end of life is likely to be that of a physical and mental wreck. The effects may not be apparent to observers other than physicians for a long time, however, although they may be present and about to cause serious trouble.

Partial restoration to health is possible by giving up alcohol, although Osler says, "Once fully established, the habit is rarely abandoned." Even after mental disease has come on, however, much may be done by proper institutional care. Such care usually is needed both because of the state of the individual's mind, and because, even if his mind is not affected, it is rarely possible for the chronic alcoholic to give up alcohol while he has access to it. The damage already done the body cannot be repaired, but more can be prevented from occurring. The harm already done may be enough to interfere with life, however.

FIG. 263. — Brain cells affected by chronic alcohol poisoning. (From Williams, "Healthful Living." By permission of The Macmillan Company, Publishers.)

The causes of chronic alcoholism have to be considered in thinking of its prevention. Heredity seems to play some part, by producing a weakness of the nervous system that seems to lead the members of a family both to indulge freely in alcohol and to be more injured by it. Environment also plays a part, in that it may supply the influence of suggestion and opportunity, causing many individuals to do what is generally "done."

Temperament is becoming increasingly considered as perhaps often the sole cause for alcoholism. While alcohol is having its effect, an individual is happy and care-free, untroubled by his sense of fatigue and failure, his worries and anxieties, or his dissatisfaction with circumstances or himself. It is natural that anything should be valued that provides

such a refuge from unpleasantness—especially a refuge that is easy and not costly. But it represents a retreat from reality on the part of the individual who cannot make reality agreeable. The reality that is unfaceable may be financial difficulties, matrimonial tangles, thwarted ambition, defeated efforts, or a mere general dissatisfaction with life.

Euphoria, meaning a sense of well-being, is perhaps the most desirable of all emotional states. The individual who becomes alcoholic often does so in order to get this feeling in the easiest way. A truly inferior individual, or one who feels himself to be so, badly needs something to make him feel like a real person. Alcohol does this for a time, and he uses it. Knowledge of its dangers does not prevent even the educated from

1 2 3 4 5

Fig. 264.—Sympathetic nerve cells; 1, healthy, 2–5, affected by chronic alcohol poisoning. (From Ritchie, "Human Physiology." Copyright 1908, 1915, 1920 by World Book Company, Yonkers-On-Hudson, New York.)

becoming a prey to it, if they cannot get a sense of importance and well-being in any other way. There are those who in sorrow and grief drink to forget; those who drink to give glamour to a drab life; those who when anxious and afraid drink to reassure themselves of their ability to meet what is before them.

Others become chronic alcoholics in their effort to make themselves socially acceptable. Alcohol does promote sociability, and there may be some excuse for the occasional use of alcohol among those whose inhibitions are so great that they cannot come in contact with others easily and naturally. Unfortunately, the lessening of inhibition by alcohol may go just too far, and the individual become socially unacceptable rather than the reverse—though he is usually unaware of it. Those who drink to gain social ease might benefit the whole

personality permanently, rather than doubtfully or temporarily, by correcting the defect that restrains them and makes them awkward among others unless artificially stimulated. It is doubtful whether freedom from repression should ever be sought through alcohol, as some urge, since alcohol does not actually change the underlying condition, and may incidentally do much physical harm.

It is possible to understand the causes that have been mentioned, and many other causes, for the taking of alcohol. But to understand them is not to accept them as inevitable. Mental hygiene has the most to offer in the prevention of alcoholism by discovering and preventing in the individual the states of mind that lead to it. An analysis of the mental state may lead to the individual being able to find safer and more lasting sources of euphoria, and being able to confront reality effectively instead of being obliged to flee from it through a drug-produced euphoria.

The narcotic drugs—opium, morphine, heroin and cocaine—are resorted to by much the same kind of individual as resorts to alcohol, and for much the same reasons. There are many victims of narcotic drugs who, however, had no knowledge of the drug they were taking at the start, having gotten into the habit by chance. Formerly, drug addiction resulted more frequently than now from the taking of patent medicines that contained these drugs. Now the Harrison Law makes it impossible for patent medicines to contain more than a very small amount, the narcotics being dispensed entirely by physicians on prescription.

Since the limitation of the sale of narcotic drugs has been brought about by Federal legislation, underground channels have been devised for distributing them. It is one of the most insidious trades in the world. So widespread and serious is it considered, that it has been given the attention of a special committee under the League of Nations. The effort on the part of those engaged in this trade, is toward developing the habit in the unsuspecting individual before he knows what the drug is that he is taking. If he can be induced to take a few doses, the habit soon becomes established. This forms one of the most important arguments against taking any medicines

of unknown composition. It takes very few doses to cause the individual to become helplessly shackled so far as his own unaided efforts to become free from the habit are concerned.

Often individuals are not innocent about the nature of the drug, but expect to escape addiction. There should be no misunderstanding about the ability to keep within reasonable limits or to avoid consequences. Practically no one who experiments with the taking of narcotics escapes the necessity for increasing the dose in order to get the same physical and mental gratification. Finally, very large doses have to be taken, much bodily harm is done, the mind is impaired and the personality sinks to a level of seeking only the satisfaction of the craving. After addiction is established, the pleasurable effect of each dose wears off quickly and is followed by weakness, depression, anxiety and disagreeable physical symptoms, such as nausea and abdominal pain. The addict will then do almost anything to get his drug.

It is unfortunate that the pleasant and relatively harmless beverages, tea and coffee, have to be included in a chapter on habit-forming drugs. It would not be necessary were there not individuals of the same neurotic trend who are capable of harmful addiction to them. As taken by the vast proportion of individuals, they are hardly a habit in the sense just spoken of. Most people take them only for their pleasant taste and can get along without them easily. It is usually when they are taken in excess that they become habit-forming.

Not only are tea and coffee usually not bad habits, but they are usually not even at all injurious. Either may, however, be injurious if taken in too large amounts, just as food may be.

Tea and coffee are not foods, except in respect to the cream and sugar served in them. The active drug in each is caffeine. It stimulates the kidneys, raises blood pressure by stimulation of the centers in the medulla, and stimulates the brain and nervous system. It has been shown that it increases working power in a definite degree. The harm done by too much tea and coffee is a possible interference with digestion and intestinal elimination; possible strain of the kidney because of substances in tea and coffee that must be eliminated; possible overstimulation of the nervous system, giving irritability

of disposition and rapid heart action; possible overstimulation of the brain giving wakefulness. None of these results follow moderate indulgence in tea and coffee by the well.

Coffee when taken in excess as a drug is usually taken for its stimulating effect. Its effect is not much noticed except when taken rarely, or when taken during fatigue, at which time it seems to do away with the feeling of fatigue, and thus may make the individual work harder and longer than he should. Those who are sluggish in the morning often find that their morning coffee definitely wakes them up. These individuals are the ones who are likely to find that coffee at night has the same effect in preventing sleep. The neurotic in particular are apparently likely to be kept from sleep by coffee taken at night, although it is not certain that the reason for their insomnia is not to be found in their nervous condition, rather than in the coffee. In many normal individuals, who have no idiosyncrasy regarding coffee, the attempt to ward off sleepiness by its use is futile.

Usually tea and coffee are not taken as drugs for their stimulating properties, but for their pleasant taste and warmth. There is nothing to fear from them unless they are taken as a substitute for food, or to postpone the need for rest. Since those who become addicts are most likely to be those who are neurotic from the start, it is natural that tea and coffee should make them more so. Probably the major part of their nervousness is a personality defect—a cause rather than a result of their becoming habituated to stimulants. If too much tea or coffee seems to be necessary, it would be well to seek for the cause of the feeling of need for them, and to set right one's physical and mental health, at the same time limiting these beverages gradually to a reasonable amount.

There are beverages dispensed at soda fountains that owe their popularity to the stimulating effect of the caffeine they contain, and also to other stimulating and somewhat habit-forming drugs. The same caution should be used regarding habituation to their use.

Tobacco is often spoken of in connection with alcohol, as if they were equally injurious to the body. Tobacco, to be sure, is almost as habit-forming as alcohol, but fortunately its effects

are vastly less serious. There is a definite tendency in its users to become accustomed to it and dependent on it. Very few tobacco users are able to discontinue its use entirely, or even temporarily, without a powerful effort of the will and the bearing of some discomfort. This is particularly true of those who inhale the smoke. In view of this fact, the matter would constitute a serious problem, were the effect of the tobacco itself serious. Tobacco appears not to injure the body structurally, but to interfere with certain functions in some, but not all, individuals.

Reports of investigations regarding the effect of tobacco seem to show that no function is actually improved by its use; the best that can be said of tobacco is that it seems to do little harm in many individuals. There are some, however, who have an idiosyncrasy to tobacco, and are adversely affected by it, either invariably or occasionally. Most individuals are somewhat affected by the first use of it, although tolerance comes on quickly for most. The tolerance usually increases, so that an individual may be able to smoke a great deal without any symptoms arising. Since the effects of tobacco are functional, it would be expected that they would not continue after the cause of them is removed. This is the case. When smoking is stopped, any symptoms of ill health that are due to it tend to disappear entirely.

Those who are affected by tobacco are usually those who smoke to excess, and inhale the smoke. They are most often affected in respect to the appetite, the digestion, the nerves and the muscles. Slight loss of appetite and slight indigestion are common symptoms. Probably most smokers acquire a somewhat irritable nervous system, especially apparent at times when they cannot smoke. Tobacco is spoken of as soothing. This is apparently the immediate effect of smoking, whereas the later effect is often irritability unless one can smoke again. It is the habitual smoker who most feels the need of being "soothed."

Uncertain, weak and trembling muscles are a common symptom of susceptibility to tobacco. Some of those who do work requiring the precise use of the small muscles of the hand find that tobacco interferes with the hand's steadiness.

One of the effects sometimes produced by smoking is irritation of the throat and larynx, sometimes even of the bronchi and the lungs. This is especially notable in those who inhale smoke. A chronic catarrhal condition of the membranes of these parts may result. This may or may not predispose to disease. Cigarette smoking is in this way the most injurious, because the smoke is most often inhaled; although cigarette smoking, if the smoke is not inhaled is the least injurious.

Blindness attributed to tobacco seems usually, if not always, to be associated with other causes of blindness. It is a temporary condition, usually curable by the discontinuing of tobacco.

Performance in various lines may be hindered by the effect of tobacco, according to the reports of some investigations. Athletic trainers, for example, usually do not permit those in training to use tobacco, because it apparently causes them to become breathless sooner. The heart action may be affected by tobacco because of the effect on the nerves regulating it, the common result being an increase in rate, thus lessening the amount of rest that the heart should get between beats. This may be injurious to individuals with already weak hearts. If the heart is strong and normal, it is not permanently damaged by the slight amount of overwork it may be called on to perform. "Tobacco heart" involves only functional disturbance, and the heart returns to normal after the excess of tobacco is stopped. Blood pressure is often somewhat increased by tobacco. This would be injurious to those whose blood pressure is already high. Since it is difficult to give up smoking, especially when one inhales, functional disturbances are often virtually permanent, in that they are continuous.

That tobacco has any great part in causing the early degeneration of the vital organs of the body—that is so serious a problem of this generation—has not yet been proved. Nevertheless, it may be that further investigation will further incriminate tobacco. Organic disease as well as functional disturbances may be found to follow poisoning by tobacco. Fifty years ago it was not understood what alcohol did to the body. Fifty years hence hygienists may be more convinced than they are now of the harm of tobacco. Some are already fully convinced.

The poison in tobacco that does the harm is probably the nicotine. Other substances are present in tobacco, but it is not probable that they are injurious also. In the liquid form, nicotine is a powerful poison. It is not certain how much of it gets into the body from smoking. Since more women have taken up smoking, the question has arisen of the possible absorption of nicotine by the child in utero. It has not yet been determined whether the nicotine passes through the placenta to the child nor that smoking by either parent has any effect on the offspring.

It is difficult for the smoker to say why he smokes. Often he does not particularly enjoy it, he says, but feels the need of it in some inexplicable way. The reason for the need is probably the same as that underlying the use of most habit-forming drugs—a physiological demand for that to which one is accustomed. Great care is needed to avoid creating a demand for any drug whose use may be harmful and whose discontinuance may be impossible. If tobacco is used at all, it should be as an occasional indulgence, and not as a necessity. Smoking should be voluntary rather than dictated by a craving.

However opinion may differ regarding the effect of tobacco, it would be generally agreed that whatever harmful effect it may have would be most likely to be noticed in the young and in those of unstable nervous constitution. It is also quite generally recognized that the adverse effects of smoking are usually more pronounced in those who smoke excessively. It so happens that the tendency to a compelling habit of excessive smoking is more marked in those who would be most likely to be injured by it—namely the neurotic.

The same observations regarding the use of tobacco apply, of course, to men as well as to women. There is no convincing evidence that tobacco produces more or different effects in one sex than in the other. It seems to be a matter of individual difference. Current regulations in many coeducational and women's colleges correspond to public opinion, which has been until recently in this country—and still is, in many parts of it—strongly opposed to smoking on the part of women. Although such opinion seems not to have been dictated by health considerations, it has nevertheless placed women on

the safe side in this matter. Even though one is not restrained by regulations or by public or family opinion, before acquiring the habit of smoking it would be well to consider the fact that there is something to be said against the use of tobacco, and little to be said in its favor. This would even be admitted by many of those who themselves use it freely. Although some, even of those who inhale, seem not to be injured in any way by it and fail to see why anybody should be so injured, it is nevertheless true that even moderate smoking should be thought of as a possible cause of interference with health. By some individuals any amount of smoking, and by all individuals excessive smoking, is to be avoided.

CHAPTER XLVIII

MEDICATION AND TREATMENT: PATENT MEDICINES

By many the physician's profession is considered not as the practice of medicine, but as the prescribing of medicine. To many the way to become well seems to be to take some medicine —almost any medicine, in fact.

It is true that certain drugs have great value when used in illness, if prescribed by physicians who understand exactly the result they wish to produce, knowing the status of the individual and the properties of the drug.

The same drugs when given carelessly to one's self or to others, by those who do not know the condition they are treating or the results the drug produces, may be the cause of serious poisoning. After learning to understand the intricacies of the body chemistry and the functions of the body, the student should respect too highly the difficulties attending the prescribing of drugs such as will be beneficial, or even safe, to attempt to treat himself or others by drugs. If a person is ill enough to need drugs, he is ill enough to have a physician, in the vast proportion of cases. All medicine is potentially poison. It is only given by physicians to avoid a more serious danger involved in not giving it.

The use of chemicals (drugs) is only legitimate when existing conditions are thoroughly understood and the need for a particular chemico-physical effect recognized. Otherwise changes may be produced that are more harmful than the original condition. The study of hygiene should increase the respect for the skilful use of drugs by physicians, and decrease respect for the haphazard use of them by laymen.

Self-medication should be avoided as definitely as self-poisoning, for self-medication often amounts to that. For example, even a simple cathartic given when the individual has unsuspected acute appendicitis as the cause of his "stom-

ach ache," might activate the intestine to such a degree as to cause the rupture of the diseased appendix. Pain-deadening drugs if taken for an ear-ache, for example, might cause the ear-ache to cease while the mastoid cells were being infected —a thing that would not have been so likely to happen had the pain from the ear been present to call attention to the need for treatment. The habitual use of even mild stimulants might cause the individual to overdo until his unperceived but genuine fatigue causes a break down. The individual who is covering up any faulty function by drugs is postponing the time when he will be obliged to recognize the illness, and is decreasing the chance of curing it easily.

The same applies to drugs of recognized composition and to patent medicines of unknown composition. For the laymen the properties of each are equally unknown, and the way it will affect him equally incalculable. Although the taking of patent medicines is particularly uncertain, it is not safe, even, to take a medicine prescribed by a doctor for one's self at a previous illness, unless one was told to take it if the exact symptoms reappeared, or was told under what circumstances to take it. Even then there is perhaps a little danger, for a layman can not always be quite certain that the circumstances are those in which he should take the medicine. It is, moreover, not safe to take medicine that is left over from a previous illness, for many drugs undergo chemical changes on ageing that render them entirely different from what they were.

It is never safe to take a medicine prescribed for somebody else, even though one's ailment is apparently the same. No two individuals have exactly the same constitution or the same ailment. One person who has a headache may have a constitution or a physiological condition that makes the particular drug prescribed for his friend virtually a poison for him.

Drugs are used by physicians for a number of purposes, but the best physicians today do not use as many drugs, or use them on as many occasions, as the best physicians of a generation ago. Formerly it was customary to ascertain the patient's symptoms and to make an attack on them. Certain drugs were said to be "good for" certain diseases. This idea still prevails among the laity. Physicians, however, do not

automatically prescribe given drugs for every case of a given ailment. There are perhaps four diseases that are always treated by giving a particular drug. These are bacterial diseases, in which it is known that the given bacteria are destroyed by a certain drug. One of these diseases is malaria, which is universally treated by quinine. Another is syphilis, which is universally treated in most of its stages by the giving of some form of arsenic.

Instead of having diseases and drugs matched up in so orderly a way that anyone could practice medicine, we are confronted by a multitude of varieties of individuals, suffering in any of a thousand ways from variations in chemico-physical processes. The way in which diseases are treated is by a study of the functions of the body, with a view to aiding them if they are not satisfactory under the circumstances. Even the individual who is ill with pneumonia may, however, need no drugs, for the body is able to cope successfully with many kinds of derangement, and to make its favorable adaptations if it is given a chance. More often than not the methods of hygiene during illness offer more hope than medicines. The use of drugs has decreased because physicians have learned that they can often offer the sick more fundamentally constructive care.

It is not intended to imply that physicians no longer have faith in drugs, but that they have more faith in the body itself. Actually there is today far more skilful use of drugs than ever before. They are now used with a scientific precision that justifies much more expectation of beneficial results. They are given, when given, for a definite purpose, and with much assurance that they will achieve that purpose.

The most important use of drugs is that of supporting any failing function of the body until it can regain its own power. Most important of all drugs are the circulatory and cardiac stimulants. Less important, but also frequently necessary are the drugs that act as sedatives to overacting functions—as, for example, the cardiac and nerve sedatives.

Another important use of drugs is to change the chemical reaction of the body or to supply missing chemicals. The use

of insulin in diabetes is one of the most brilliant illustrations of the latter use of a drug.

Sometimes drugs are used to allay pain. They are so used only when the cause of the pain is known, because to mask the pain might mean hiding the progress of the disease. Pain is a danger signal one cannot do without. After a diagnosis has been made, and pain no longer serves any function, if it cannot be relieved in other ways it is often treated directly by drugs. That physicians can relieve pain is one of the chief reasons for the confidence many individuals have in them, who do not know that physicians can do far more for them than that, by methods directed toward the normalizing of function.

Medication applied to the surface of the body (skin and mucous membranes) is largely for the purpose of cleansing or disinfecting or soothing it, or of stimulating or lessening the natural secretions. Skin disinfectants of many sorts are fairly useful, but it is hard to disinfect the mucous membranes without injuring them. Applications to the mucous membranes must be made with great care. There are those that may be used with safety on the membranes of the nose and throat, although their disinfectant effect is not very powerful as a rule.

Any function of the body may be influenced by drugs. It is credulous to expect too much of them, but it is credulous and stupid to expect anything but harm from ignorantly administered drugs. On the other hand it is too great incredulity to expect nothing of drugs when scientifically administered.

There are other therapeutic measures of as great importance in many cases as drugs. Chief among these are the various biological substances used against bacteria. Some of these are curative and some are prophylactic; some may be used in both ways. It is not a question of the comparative value of these preparations and of other forms of treatment. If a biological preparation is available it should always be used, regardless of the parallel necessity, perhaps, for the supportive or other effects of drugs. Such preparations as antitoxin against diphtheria have unique powers, that are totally beyond dispute.

Physiotherapy is a term used to include all sorts of treatment by physical rather than chemical agents—heat, cold, sun, radium, X-ray, electricity, exercise, mechanical appliances, massage, baths, enemas, douches, inhalation of steam, etc.

Surgery involves the treatment of diseases by manual means or by operations. Sometimes it involves the removal of parts of the body that are a menace to health; sometimes, the joining of two separated parts; sometimes, the separating of one part from another; sometimes, the opening of a part to remove accumulated fluid or other interfering material, perhaps something that has gotten in from outside. It involves the reducing of dislocations, and the setting of fractures, and many kinds of mechanical correction of defects in structure that interfere with function. When surgery is needed nothing else will usually serve as well.

There are times when the chances are so much against health without surgical intervention that no physicians would care to take them. Where the chance is perhaps one to ten it stands to reason that, according to the law of averages, there should be individuals who have been advised on this basis to have an operation and have not had the operation, but have recovered. They represent the one in the ten. However, most individuals would not care to take such risks.

Physicians do not advise operations unless they know the chances are against health without it. Before reaching conclusions in doubtful cases they often consult with other physicians in order that any doubt of the necessity for the operation may be removed. Operations, if done when advised, if the advice has not been received too late, are usually successful and curative. The greatest danger of operations comes when one has waited, expecting to be able to avoid it. Remarkable progress has been made in surgery in recent years, so that no one need unduly fear an operation done by a skilful surgeon.

Patent Medicines

The question of patent medicine control is an important part of public health, but the question of patent medicine consuming is a personal matter. However many of such substances are on the market, they may be bought and taken

or not, as one chooses. There would be no public problem, because there would be few patent medicines, if individuals did not supply so large a market.

The patenting itself merely implies a procedure through which a manufacturer obtains the sole right to make a given article, over which he has a monopoly. Some few very important medicines have been patented in order to make certain that the quality is always the same. It is a scientific monopoly in the interest of correct manufacture in such a case.

Other medicines that are patented represent more or less standard prescriptions. Some medicines that are patented have recognized standing because their contents are known by pharmicists and physicians. The owner merely charges a little more for them, to balance the convenience he offers the public in having the medicine already prepared ready to sell, rather than having it made up for each customer.

Many patent medicines are not injurious, but are not capable of doing what they are said to be able to do. Others are worthless because inert (without active medicinal properties). In some cases patent medicines are actually harmful.

Those that are least harmful are those that contain little if anything that has any effect, one way or the other. The harm then consists in believing that something is being done for the ailment for which they are taken, and in this way preventing or delaying proper treatment.

Those that are most harmful contain powerful, actually injurious drugs, or drugs that are unsafe because injurious to some individuals if not to all. The acme of harmfulness in patent medicines is reached when they contain habit-forming drugs—formerly a greater danger than now. At present the quantities must be less than a certain stipulated small amount in order to be purchasable direct by laymen. For those containing large quantities, druggists are required to have a doctor's prescription before selling them. Drug addiction is possible even from the small amounts now permitted. The immense popularity of certain patent medicines is due to their alcohol or narcotic drug content.

Patent medicines bear the statement "Guaranteed under the Food and Drugs Act." This means only that the medicine

has been analyzed and contains what it is said on the trade label to contain of any of eleven specified harmful drugs (alcohol, morphine, opium, cocain, etc.).

There is some misconception about the nature of this guarantee. It does not mean that the government guarantees anything except the advertised content in respect to these eleven drugs. It has no reference whatever to any other drugs that may be as powerful and injurious. For example, arsenic and strychnine need not be mentioned on the label. Furthermore, it has no reference to the truth of the claims of the manufacturer, as stated on the package, regarding the curative properties of the drug, except when they are misleading or false regarding the composition or origin, and false and fraudulent regarding curative powers. This guarantee does not cover claims made in circulars or in newspaper advertising, nor even the indirect statements made on packages and bottle labels from which one is intended to infer certain things. Herein lies the great danger of certain patent medicines. If one does not know all that he is taking, he can therefore have no idea how it is going to affect him.

Although the patenting of a medicine represents a monopoly of that particular medicine, the business is still highly competitive in that someone else may patent another medicine that claims to accomplish the same results. This usually results in keeping prices within limits, but it introduces the new element of competitive advertising. In order to advertise a medicine successfully, one must usually make extravagant claims for it, or entirely false claims—and what is even worse, one must usually lead the reader to fear the ailment the medicine is "good for," and to imagine he needs it. Much taking of patent medicines is a result of suggestive advertising. There is legislation against using the mails to defraud, and some of the worst offenders have been brought to justice in this way. The fact that a given patent medicine has been on the market for years does not, however, prove anything except that its advertising has been skilful.

One of the important aids to advertising is the "testimonial." An Attorney-General of the United States, in a communication to the Postmaster General, said: "Speaking generally, it

may be said that in all my experience in the office, never has a medical concern, no matter how fraudulent its methods or worthless its treatment, been unable to produce an almost

MEDICAL TESTIMONIAL GATHERERS—EXperienced; leads furnished; give references. Address O 355, Tribune.

FIG. 265.—(Used by permission of the American Medical Association.)

Holyoke Daily Transcript.

HOLYOKE DAILY TRANSCRIPT, FRIDAY, MAY 11, 1917—TWENTY PAGES.

THREE IN ONE FAMILY MAKES UNUSUAL CASE

South Hadley Falls Man Relieved of Stomach Trouble Since Taking Tanlac the National Tonic.

"I HAVE GAINED 10 POUNDS"

Says Fred Wicks, and My Wife and Son Are Also Taking Tanlac and Have Been Greatly Benefited."

Health is wealth Health is the greatest wealth in the world—the soundest capital, the biggest asset. Without health the bloated bond holder is a pauper. With health the plodding laborer is rich All the money in the world cannot buy this asset of health that is absolutely necessary for success of any kind The man without health is beaten before he begins his fight. He does not even qualify for a trial. He is barred from ever trying.

Mr Fred Wicks of 52 Granby Road, South Hadley Falls, Mass., has been relieved of stomach trouble and has gained 10 pounds in weight since taking Tanlac His wife and son are also taking it and have been greatly bene-
Mr Wicks made and signed the
ing statement at George
Dr

FUNERALS

WICK—The funeral of Fred Wick was held this morning from his home, Granby Road, South Hadley Falls, followed by a high mass of requiem in St. Patrick's church. Rev J. E. Sellig officiated. The bearers were Jacob and John Miller, Charles Todt, Charles P. O'Connor, John St. John and James Kelly. The burial was held in the St. Jerome cemetery.

FIG. 266.—(Used by permission of the American Medical Association.)

unlimited number of the so-called testimonial letters."[1] Testimonial gatherers are even advertised for. Often the

[1] Quoted in a pamphlet on Testimonals published by the American Medical Association.

testimonials are presumably paid for in cash; often they are genuine statements, sometimes from very celebrated but very credulous individuals. There are instances in which the testimonial occurred in one column of a newspaper, stating cure, while in another column was the death notice of the cured individual.

At the moment, "reducing" medicines are attracting more attention than many others. Dr. Wiley in "Good Housekeep-

FIG. 267.—(Used by permission of the American Medical Association.)

ing" of January, 1914, says, "As the rage for slimness grows apace, with apparently no limit in sight, the number, audacity and unadulterated foolishness of the alleged obesity-cures and flesh-reducers keep step with the demand. Some are merely picturesque and amusing; some are dangerous; all are misleading." Some of the cures urge as an advantage that the individuals taking it need not diet nor exercise. Since these two ways of reducing are to the obese rather unpleasant, the cures that involve merely taking medicine are alluring to those

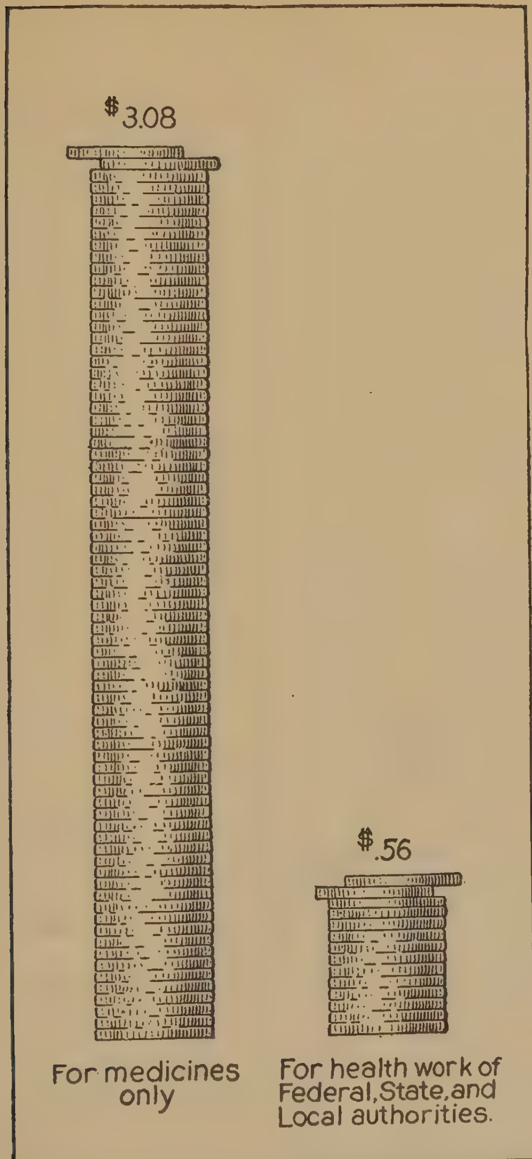


FIG. 268.—Cost per capita to the public for all medicines (excepting biological products,) manufactured in 1921 in the United States and for official health activities the same year. (From Moore, "Public Health in the United States," Published by Harper & Bros.)

who lack control of appetite and are too lazy to exercise. But there is only one drug that actually causes loss of weight, and that is so dangerous if unwisely used that its public sale should be prohibited. It is contained in some obesity cures. Reducing medicines may contain cathartics and result partly successfully by too rapid elimination of nutritive material. Others that result partly successfully are those that specify certain dietary regulations and exercise while taking the medicine, to which causes any degree of success is due.

Other fake anti-fat remedies are intended to be rubbed on the body. No effect may be produced by any drug used in this way, although the associated exercise and massage may do some good. There is nothing more pathetic than a vanity so great and an intelligence so low as to cause one to fall victim to the most outrageously impossible obesity cures.

Although it appeals to the emotions and to the credulity to try to conjure health instead of earning it, it must be recognized that there are no magic short cuts to health. The law of cause and effect always is working. One is not justified in expecting anything except from the most logical efforts to harmonize cause and effect, which the indiscriminate taking of patent medicines does not even attempt. All drugs that are not inert, affect body chemistry, and body chemistry is too intricate to be meddled with ignorantly.

The amount of money that is spent for the cure of ailments supposedly but not actually present; for ailments that would cure themselves; for ailments incurable by any drugs—the amount spent not only futilely but to the actual harm of the individuals taking them—is enormous. If the same amount were spent for regular medical advice, not only would there be a saving of wasted money, but a saving of wasted health.

APPENDIX I

Chemical Composition of American Food Materials

Abstracted from tables by Atwater and Bryant, as given in Bulletin No. 28, United States Department of Agriculture, Office of Experiment Stations. Starred items are from table by Woods, as given in Farmers' Bulletin No. 34, United States Department of Agriculture.

(Decimal fractions have been omitted except in the case of the percentages under six. In other cases the nearest whole number has been used.)

Food material	Water, per cent	Protein, per cent	Fat, per cent	Carbo-hydrate, per cent	Mineral ash, per cent	Fuel value per pound
Animal Food						
Meat						
Beef; roast	48	22	29	....	1.3	1620
sirloin steak	64	25	10	....	1.4	875
corned beef	54	15	26	....	4.9	1395
dried, smoked, salted	45	39	5.4	....	11	960
tongue	51	19	23	....	4	1340
Veal; leg, roast	72	21	7	....	1.1	670
calf's liver	73	19	5.3	....	1.3	575
Lamb; roast	67	20	13	....	.8	900
chops	48	22	30	....	1.3	1665
Mutton; leg, roast	51	25	23	....	1.2	1420
Pork; chops	51	16	32	....	.9	1655
loin, roast	66	19	13	....	1	900
boiled ham	51	20	22	....	6	1320
fried ham	37	22	33	....	6	1815
bacon	20	10	65	....	5.1	2930
sausages	40	13	44	1.1	2.2	2125
Frankforters	57	20	19	1.1	3.4	1170
*Chicken; broiler	70	21	8	....	1.1	890
canned, boned	58	28	13	....	2.2	1240
*Turkey; roast, dark meat	54	39	4.3	....	2.2	1200
roast, light meat	58	35	4.9	....	1.8	1090
Fish						
Bluefish	78	19	1.2	....	1.3	410
Cod, fresh	80	19	.5	....	1.2	370
Cod, salt, boneless	55	27	.3	....	19	490

CHEMICAL COMPOSITION OF AMERICAN FOOD MATERIALS.—(*Continued*)

Food material	Water, per cent	Protein, per cent	Fat, per cent	Carbo-hydrate, per cent	Mineral ash, per cent	Fuel value per pound
Fish, cont'd.						
Haddock	82	17	.3	....	1.2	335
Halibut	75	19	5.2	....	1	565
Herring, fresh	72	19	7	....	1.5	660
Herring, smoked	35	37	16	....	13	1335
Mackerel, fresh	73	19	7	....	1.2	645
Mackerel, salt	43	17	26	....	13	1435
Salmon, fresh	65	22	13	....	1.4	950
Salmon, canned	63	22	12	....	2.6	915
Sardines, canned	52	23	20	....	5.6	1260
Shad	71	19	9	....	1.3	750
Shad roe	71	21	3.8	....	1.5	600
Trout	78	19	2.1	....	1.2	445
Shell fish						
Clams	81	11	1.1	5.2	2.3	340
Crabmeat, canned	80	16	1.5	.7	2	370
Lobster, whole	79	16	1.8	.4	2.2	390
Lobster, canned	78	18	1.1	.5	2.5	390
Oysters	88	6	1.3	3.3	1.1	230
Scallops	80	15	.1	3.4	1.4	345
Dairy Products, etc.						
Milk, whole	87	3.3	4	5	.7	325
Milk, condensed, sweetened	27	9	8	54	1.9	1520
Buttermilk	91	3	.5	4.8	.7	165
Cream	74	2.5	18	4.5	.5	910
Butter	11	1	85	....	3	3605
Cheese, American	32	29	36	.3	3.4	2055
Cream	34	26	34	2.4	3.8	1950
Roquefort	39	23	29	1.8	7	1700
Eggs, whole	74	13	10	....	1	720
whites	86	12	.2	....	.6	250
yolks	49	16	33	....	1.1	1705
Oleomargarine	9	1.2	83	....	6	3525
Gelatine	14	84	.1	....	2.1	1705
Foods from the vegetable Kingdom						
Cereals, etc.						
Oatmeal	84	2.8	5	11	.7	285
Hominy	79	2.2	.2	18	.5	380

Chemical Composition of American Food Materials.—(*Continued*)

Food material	Water, per cent	Protein, per cent	Fat, per cent	Carbo-hydrate, per cent	Mineral ash, per cent	Fuel value per pound
Cereals, etc., cont'd.						
Macaroni	78	3	1.5	16	1.3	415
Rice	72	2.8	.1	24	.2	510
Shredded wheat	8	10	1.4	78	2.1	1700
Bread, Pastry, etc.						
White bread	35	9	1.3	53	1.1	1215
Brown bread	44	5.4	1.8	47	2.1	1050
Gluten bread	38	9	1.4	50	1.3	1160
Whole wheat bread	37	10	.9	50	1.3	1140
Boston crackers	8	11	8	71	1.9	1885
Graham crackers	5	10	9	74	1.4	1955
Pretzels	9	9	4	73	4	1700
Cake, etc.						
Chocolate layer cake	20	6	8	64	1.1	1650
Fruit cake	17	6	11	64	1.8	1760
Sponge cake	15	6	11	66	1.8	1795
Doughnuts	18	7	21	53	.9	2000
Gingerbread	19	6	9	63	2.9	1670
Lady fingers	15	9	5	71	.6	1685
Macaroons	12	6	15	65	.8	1975
Pie						
Apple	42	3	10	43	1.8	1270
Custard	62	4.2	6	26	1	830
Lemon meringue	47	3.6	10	37	1.5	1190
Mince	41	6	12	38	2.5	1335
Raisin	37	3	11	47	1.5	1410
Squash	64	4.4	8	22	1.3	840
Pudding						
Indian cornmeal	61	5	5	27	1.5	815
Rice pudding	60	4	5	31	.6	825
Tapioca pudding	64	3.3	3.2	28	.8	720
Sugars						
White sugar	....	....	....	100	....	1860
Maple sugar	....	....	....	83	....	1540
Maple syrup	....	....	....	71	....	1330
Honey	18	.4	....	81	.2	1520
Candy (average composition)	....	....	....	96	....	1785

Chemical Composition of American Food Materials.—(*Continued*)

Food material	Water, per cent	Protein, per cent	Fat, per cent	Carbohydrate, per cent	Mineral ash, per cent	Fuel value per pound
Vegetables						
Asparagus	94	1.8	.2	3.3	.7	105
Beans, string	89	2.3	.3	7.4	.8	195
Beans, Lima	68	7.1	.7	22	1.7	570
Beets	87	1.6	.1	10	1.1	215
Cabbage	91	1.6	.3	5.6	1	145
Carrots	88	1.1	.4	9	1	210
Cauliflower	92	1.8	.5	4.7	.7	140
Celery	94	1.1	.1	3.3	1	85
Corn, green, sweet	75	3.1	1.1	20	.7	470
Cucumbers	95	.8	.2	3.1	.5	80
Egg plant	93	1.2	.3	5.1	.5	130
Lettuce	95	1.2	.3	2.9	.9	90
Mushrooms	88	3.5	.4	7	1.2	210
Onions	88	1.6	.3	10	.6	225
Parsnips	83	1.6	.5	13	1.4	300
Peas, green	75	7	.5	17	1	465
Potatoes	78	2.2	.1	18	1	385
Potatoes, sweet	69	1.8	.7	27	1.1	570
Pumpkin	93	1	.1	5.2	.6	120
Radishes	92	1.3	.1	5.8	1	135
Rhubarb	94	.6	.7	3.6	.7	105
Spinach	92	2.1	.3	3.2	2.1	110
Squash	88	1.4	.5	9	.8	215
Tomatoes	94	.9	.4	3.9	.5	105
Turnips	90	1.3	.2	8	.8	185
Vegetables, canned						
Beans, baked	69	7	2.5	20	2.1	600
Beans, string	94	1.1	.1	3.8	1.3	95
Beans, Lima	79	4	.3	15	1.6	360
Beans, red kidney	73	7	.2	18	1.6	480
Brussels sprouts	94	1.5	.1	3.4	1.3	95
Corn	76	2.8	1.2	19	.9	455
Peas	85	3.6	.2	10	1.1	255
Succotash	76	3.6	1	19	.9	455
Tomatoes	94	1.2	.2	4	.6	105
Olives, green	58	1.1	28	12	1.7	1400
Olives, ripe	65	1.7	26	4.3	3.4	1205

Chemical Composition of American Food Materials.—(*Continued*)

Food material	Water, per cent	Protein, per cent	Fat, per cent	Carbo-hydrate, per cent	Mineral ash, per cent	Fuel value per pound
Fruits						
Apples	85	.4	.5	14	.3	290
Bananas	75	1.3	.6	22	.8	460
Blackberries	86	1.3	1	11	.5	270
Cherries	81	1	.8	17	.6	365
Grapes	77	1.3	1.6	19	.5	450
Huckleberries	82	.6	.6	17	.3	345
Lemons	89	1	.7	8	.5	205
Muskmelon	89	.6	....	9	.6	185
Oranges	87	.8	.2	12	.5	240
Peaches	89	.7	.1	9	.4	190
Pears	84	.6	.5	14	.4	295
Pineapples	89	.4	.3	10	.3	200
Plums	78	1	....	20	.5	395
Prunes	80	.9	....	19	.6	370
Raspberries	84	1.7	1	13	.6	310
Strawberries	90	1	.6	7	.6	180
Watermelon	92	.4	.2	7	.3	140
Fruits, canned						
Apricots	81	.9	....	17	.4	340
Blackberries	40	.8	2.1	56	.7	1150
Blueberries	86	.6	.6	13	.4	275
Cherries	77	1.1	.1	21	.5	415
Orange marmalade	14	.6	.1	85	.3	1585
Peaches	88	.7	.1	11	.3	220
Pears	81	.3	.3	18	.3	355
Pineapple	62	.4	.7	36	.7	715
Strawberries	75	.7	....	24	.5	460
Fruits, dried						
Currants	17	2.4	1.7	74	4.5	1495
Dates	15	2.1	2.8	78	1.3	1615
Figs	19	4.3	.3	74	2.4	1475
Raisins	15	2.6	3.3	76	3.4	1605
Nuts						
Almonds	4.8	21	55	17	2	3030
Brazilnuts	5	17	67	7	3.9	3265
Butternuts	4.4	28	61	3.5	2.9	3165
Chestnuts	45	6	5.4	42	1.3	1125
Cocoanut	14	6	51	28	1.7	2760

Chemical Composition of American Food Materials.—(*Continued*)

Food material	Water, per cent	Protein, per cent	Fat, per cent	Carbo-hydrate, per cent	Mineral ash, per cent	Fuel value per pound
Nuts, cont'd.						
Filberts	3.7	16	65	13	2.4	3290
Peanuts	9	26	39	24	2	2560
Peanut butter	2	29	46	17	5	2825
Pecans	3	11	71	13	1.5	3455
Pistachio nuts	4.2	22	54	16	3.2	2995
Walnuts	2.5	28	56	12	1.9	3105
Soups						
Beef	93	4.4	.4	1.1	1.2	120
Bean	84	3.2	1.4	9	1.7	295
Chicken	84	10	.8	2.4	2	275
Clam chowder	89	1.8	.8	7	2	195
Meat stew	84	4.6	4.3	5.5	1.1	370
Soups, canned						
Asparagus	87	2.5	3.2	5	1.4	285
Bouillon	97	2.2	.1	.2	.9	50
Celery	89	2.1	2.8	5	1.5	250
Chicken	94	3.6	.1	1.5	1	100
Julienne	96	2.7	....	.5	.9	60
Mock turtle	90	5.2	.9	2.8	1.3	185
Mulligatawny	89	3.7	.1	6	1.2	180
Oxtail	89	4	1.3	4.3	1.6	210
Pea	87	3.6	.7	8	1.2	235
Tomato	90	1.8	1.1	5.6	1.5	185
Vegetable	96	2.9	....	.5	.9	65

APPENDIX II

100-calorie Portions

In this table are given the amounts of certain common foods that yield approximately 100 calories. The amounts given are estimates based on a comparison of the findings of a number of different investigators, who obtained their figures by actually weighing and measuring foods. The figures representing the percentage composition of foods, on which the computation of 100-calorie portions are usually made, are those of the United States Department of Agriculture, as given in Bulletin No. 28, which is also the authority for the percentages given in Table I. Complete accuracy regarding the amount of a given food that will yield 100-calories is not possible, because of the variation in the composition of food. Even lean meat varies in its percentage composition, and prepared foods vary according to the recipe which is used. Average composition has been the basis of the estimates. Furthermore the amounts have in many cases had to be given in indefinite terms. This criticism is particularly applicable in respect to the term "serving," which is by no means standardized. Allowance should be made for such variations in the composition of food and in the size of indefinitely described portions. Many of the foods listed are regularly served with such substances as cream, sugar, butter, cream sauces or salad dressing, which have high fuel value. Unless these additional food substances have been taken into consideration in the table, they should be computed and added to the total caloric value of the foods with which they are eaten.

Meat and Fish

(Variation in caloric value is chiefly according to variation in proportion of fat. Round lean portion of French lamb chop weighs about 1 ounce, and yields about 100 calories. Portions of meat may be compared with this amount as a standard.)

Sirloin steak	medium serving
Tenderloin steak	small serving ($2 \times 1 \times 1$ inches)
Hamburg steak	1 medium cake
Roast beef	small serving ($4 \times 2 \times \frac{1}{4}$ inches)
Filet of beef	small serving
Corned beef	small serving
Beef loaf	medium slice
Tongue	small serving

Meat and Fish, cont'd	
Dried beef, creamed	⅓ cup
Veal, roast	medium serving
Lamb, roast	medium serving
Lamb chop	small chop
Pork, roast, lean	medium serving
Ham, boiled	small serving
Ham, roast	small serving
Bacon, fried	4 or 5 small slices
Frankforters	1
Chicken, roast	medium serving
Chicken, creamed	¼ cup
Turkey, roast	small serving
Duck, roast	small serving
Bluefish	large serving
Cod	large serving
Haddock	large serving
Halibut	large serving
Mackerel	medium serving
Salmon	medium serving
Sardines	3–6
Fish cake	1
Lobster	3 heaping tablespoonfuls
Lobster, canned	¾ cup
Clams	12 medium
Oysters	12 small
Scallops	2 heaping tablespoonfuls
Eggs	
Raw or cooked	1 very large 1⅓ medium
Vegetables	
Asparagus	20 stalks
Beans, baked	⅓ cup
Beans, string	2 cups
Beets	1⅓ cups
Cabbage, shredded	5 cups
Carrots	1½ cups
Cauliflower	small head
Celery	1 bunch
Corn, canned	⅓ cup
Corn, on cob	2 small ears
Cucumbers	3 medium
Lettuce	2 large heads
Macaroni	2 servings (1 cup)
Mushrooms	12 medium
Olives	6–8

Vegetables, cont'd	
Onions	3 to 4 (2 servings)
Parsnips, creamed	2 servings
Peas	¾ cup
Potatoes	
boiled	1 large
baked	1 large
mashed	½ cup
sweet	½
Radishes	36
Spinach	2½ cups
Tomatoes	
canned	1¾ cups
stuffed	1
fresh	4 medium
Turnips, creamed	2 servings
Cream sauce	⅓ cup
Fruits	
Apple	2
Apple sauce	⅜ cup
Apricots (canned)	3 halves with 2 tablespoonfuls juice
Banana	1 large
Blackberries (fresh)	½ cup
Blueberries (fresh)	1 cup
Cantaloupe	1 melon (4½″ diameter)
Dates	3 large
Figs	1 large
Grapes, Concord	1 large bunch
Orange	1 very large
Peach	3
Peaches (canned)	2 large halves with juice
Pear	1 large
Pears (canned)	2 halves with juice
Pineapple (canned)	1 slice with juice
Prunes, stewed	3 medium, with juice
Raisins	¼ cup
Rhubarb, stewed	½ cup
Strawberries (fresh)	1⅓ cups
Cereals	
Cornflakes	1¼ cups
Grapenuts	3 tablespoonfuls
Oatmeal, cooked	1 cup
Puffed rice	1⅓ cups
Puffed wheat	1⅔ cups
Shredded wheat	1 biscuit

Dairy Products	
Butter	½ oz. or 1 tablespoonful or 1 large pat
Buttermilk	large glass
Cream	¼ cup
Cheese, American	1½″ cube
Cheese, cottage	4″ cube
Milk	small glass (⅝ cup)
Bread, Rolls and Crackers	
Bread, white	thick slice, medium size
Bread, whole wheat	thick slice, medium size
Bread, corn	2″ cube
Baking powder biscuit	2 small
Graham crackers	2
Oyster crackers	24
Saltines	6
Griddle cakes	1 cake (4½″ diameter)
Corn muffins	¾
Popovers	1
French rolls	1
Club sandwich	⅙
French toast	1 slice
Waffles	½ waffle (6″ diameter)
Desserts	
Boiled custard	⅓ cup
Cup custard	⅓ cup
Ice cream, average	2½ heaping tablespoonfuls
Chocolate sauce	1 tablespoonful
Preserved fruit sauce, sweetened	2 tablespoonfuls
Sherbert and water ices	½ cup
Milk sherbert	¼ cup
Lemon jelly	½ cup
Coffee jelly	1¼ cups
Baked apple with sugar	½ large
Baked apple with cream	¼ large
Rice pudding	ordinary serving
Rice pudding with cream	½ serving
Blanc mange	ordinary serving
Apple pie	1½″ sector (diameter 9″)
Custard pie	2″ sector (diameter 9″)
Lemon meringue pie	1″ sector (diameter 9″)
Mince pie	1″ sector (diameter 9″)
Squash pie	2″ sector (diameter 9″)
Doughnuts	½
Gingerbread	2″ cube
Macaroons	2
Sponge cake	size of thick slice of bread

Desserts, cont'd.	
Fruit cake	thin slice
Fudge cake	slice 2 × 1 × 1 inches
Accessories	
Sugar	2 dominoes (2 tablespoonfuls)
Honey	1 tablespoonful
Maple sugar	4 teaspoonfuls
Maple syrup	1½ tablespoonfuls
Marmalade	3 teaspoonfuls
Nuts	
Peanuts	10–12 double
Walnuts	8–16
Almonds	8–10
Peanut butter	2½ teaspoonfuls
Candy	
Fudge	1 large piece
Caramels	1″ cube
Chocolate peppermint	one medium
Foods as served	
Chicken salad	1 small serving
Fruit salad with French dressing	1 serving
Lettuce salad with French dressing	1 serving
Waldorf salad	½ serving
Mayonnaise dressing	1 tablespoonful
Olive oil	1 tablespoonful
Soups	
Bouillon	4 cups
Cream soup, average	2 plates
Bean soup	large plate
Pepared Dishes with Cheese	
Macaroni and cheese	½ cup
Welsh rarebit on toast	1½ tablespoonfuls with ½ slice toast
Beverages	
Cocoa average	½ cup
Egg lemonade	½ cup
Eggnog	½ cup
Fruit punch, sweetened	½ cup
Lemonade	large glass (1⅔ cups)
Orange juice	1 cup
Grape juice	½ cup

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with the Teacher,

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Tyranny and Bohemianism
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Principle of Gov.

1. Sword - Reason
" Force - Public
" Authority - consent.

Mendels Law.
1. Independent unit characters.
2. Dominance
3. Segregation, purity of the germ cells.

Poison Ivy ~~Cure~~ Remedy
Grindelia Robusta
1 t. " to 3 t. water.
Jewel weed in summer

to get results.

Automobiles
drawings
burns
falls
street-cars

Joe
Medicine

Aims of Health Education
to instruct [illegible] + youth
they may [illegible] and
prove th[illegible] health.
to establish in them
habits and principles
[illegible] which throughout
school life, and later
will assure that
[illegible] + [illegible] + vital
[illegible] provide a base
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[illegible] + [illegible] in
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conscious guidance + control.